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CONTENTS

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FLIGHT IDENTIFICATION OF INDIAN RAPTORS WITH PALE BARS ON UPPER WINGS[1]

WILLIAM S. CLARK[2] AND N. JOHN SCHMITT[3]

(With two colour plates)

INTRODUCTION

Diurnal raptors are notoriously difficult to identify in flight; raptors in India are even more so than in most other areas because of the greater number of species (68) and the lack of definitive information in bird field guides. In Europe raptor flight identification is easier not only because there are fewer species (38), but also because there is a very good specialized field guide (Porter *et al.* 1981). This guide is effective because it depicts correctly wing and tail shapes of the raptors, as well as pointing out definitive *field marks*, that is, noticeable features of each species that serve to distinguish it from other species.

No fewer than nine species of raptors that occur commonly over much of India share one field mark: a pale bar across each upperwing (Plate 1). Four of these — black kite *Milvus migrans*, booted eagle *Hieraaetus pennatus*, short-toed eagle *Circaetus gallicus*, and white-eyed buzzard *Butastur teesa* — show this field mark in all plumages. The other five — brahminy kite *Haliastur indus,* crested honey buzzard *Pernis ptilorhyncus,* crested hawk-eagle *Spizaetus cirrhatus*, crested serpent eagle *Spilornis cheela*, and Bonelli's eagle *Hieraaetus fasciatus* —show this mark only in juvenile plumage.

In spite of sharing this field mark, all nine are quite different, particularly when seen from below, and can be easily distinguished from each other by the use of other field marks, especially wing and tail shape.

We present herein, through simple text and illustrations, the field marks that can be used effectively to identify all nine species in flight.

MATERIAL AND METHODS

Field marks to distinguish these nine species were determined from our previous experiences, by reviewing the pertinent literature, including bird field guides and handbooks, by studying museum specimens, both in India and at major collections in the United Kingdom and United States of America, by studying many photographs of raptors in the field, and by observing raptors in the field in many parts of India. Particularly helpful to us was Porter *et al.* (1981), as many species of European raptors (31) also occur in India. We field-tested the field marks presented here in the field in many parts of India during travel with the BNHS Birds of Prey Project surveys.

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Results

The field marks, including wing and tail shapes and overall proportions, that will positively identify each of the nine species with pale bars on upperwings are illustrated in Plate 1 (from above) and Plate 2 (from below) and are summarised under the heading 'CAPTIONS FOR PLATES.' These are discussed below in more detail by species.

Black kite: (This name for *Milvus migrans* applies to all races; pariah kite is unknown outside of India). This distinctive raptor is common, widespread, and easily identified. The next two species are similar and could be confused with it, but its long forked tail is always definitive. However, caution is called for because the tail appears somewhat more square when fanned and a few individuals will show a somewhat rounded tail. Also definitive is the barring on the pale primary panels. Subspecific differences between *M. m. govinda* and *M. m. lineatus* are not always seen in the field.

Booted eagle: This winter visitor is fairly common over most of India and can be confused with the black kite. Like that species it is aerial, hunting on the wing from morning to afternoon. It occurs in three colour morphs: pale, dark, and newly described rufous (see Clark 1989). Dark- and rufous-morph birds are similar to black kites, but the white uppertail coverts, more rounded tail, pale 'head lights,' and dark line through the underwings of the rufous morph are diagnostic. All colour morphs appear alike from above.

Brahminy kite: Juvenile brahminy kites are similar in silhouette to black kites and booted eagles, but note the pale head and breast, rounded, unbanded tail, and larger, creamy primary panels on the underwings.

The next four species show pale wing bars only during their first year while in juvenile plumage. This plumage is quite different in all four from the respective adult plumages. All four juveniles are similar to each other in being rather pale buffy to creamy on the underparts and underwing coverts, and have less distinct pale bars on the upperwings than do the previous three species.

Crested honey buzzard: This species has a distinctively long, slender neck and head that it moves constantly from side to side while in flight. Its comparatively narrow wings with darker secondaries on the underwing and its distinctive tail pattern are sufficient for identification.

Crested hawk-eagle: Compared to the other species considered here, it has a longer, distinctively banded tail and more strongly barred undersides of primaries. The crest, if present, is visible only on birds seen flying near (Plate 1). The juvenile of the crestless changeable hawk-eagle *Spizaetus c. limnaeetus* is otherwise identical to the juvenile of the crested hawk-eagle.

Crested serpent eagle: This is the most easily identified of these four juveniles, because of its black face patches, rufous underwing markings, strong tail pattern, and heavily streaked breast.

Bonelli's eagle: Juveniles of this species have rufous underparts when they fledge. But this colour fades rather quickly, so that by winter they appear quite creamy on the underparts. The black line on the underwing may be prominent or indistinct or, in some cases, even absent. One field mark, darker secondaries on underwing, is shared with crested honey buzzard, but the indistinct banding on secondaries and tail and thicker head and shorter neck of this species separate it from the other.

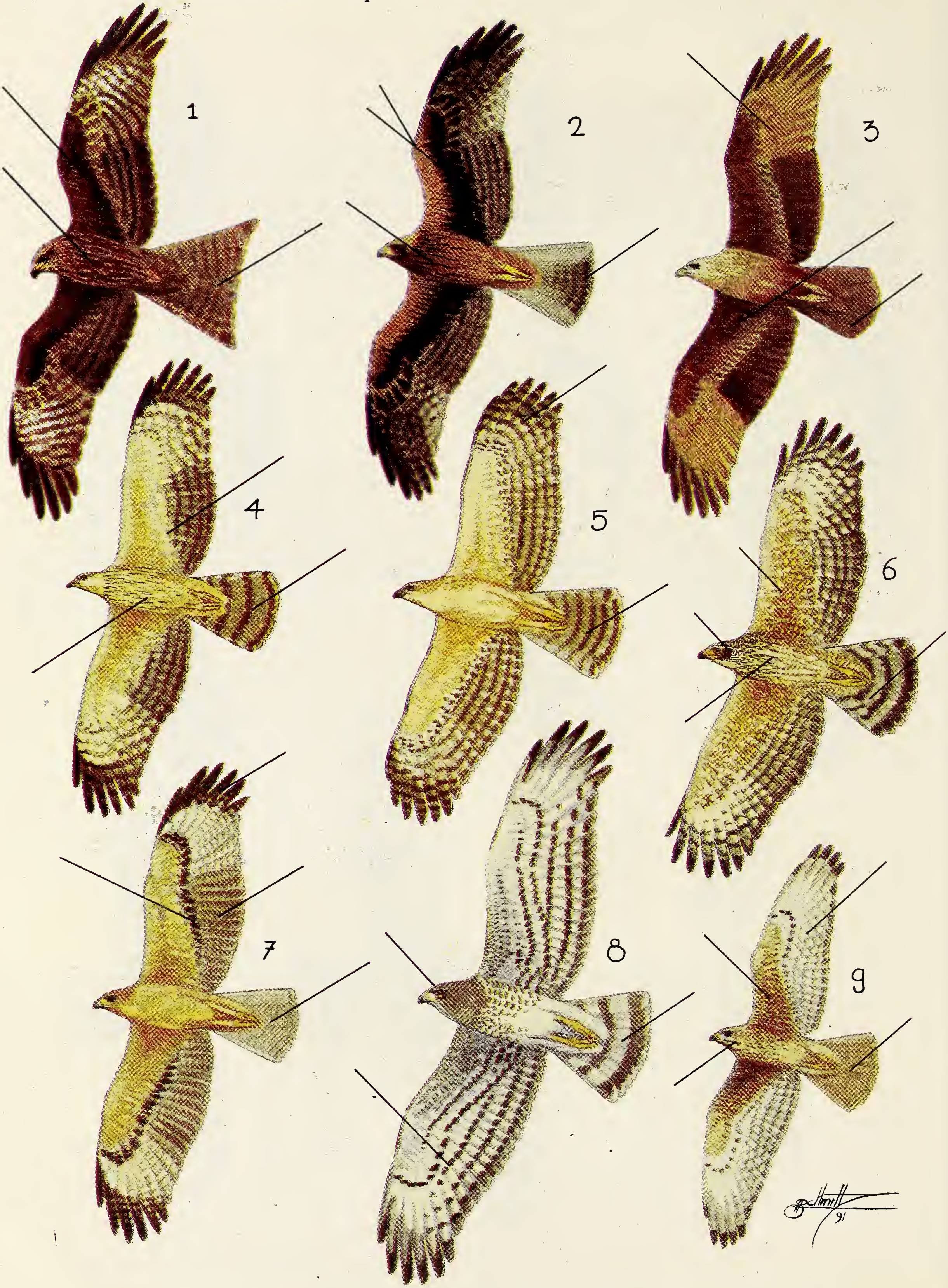
Short-toed eagle: This species is the largest of the nine. Its pale upperwing bars are somewhat wider than all the others, except those of the white-eyed buzzard. The dark hood, lack of creamy tones on undersides, and strong banding on underwings are distinctive.

White-eyed buzzard: This is the smallest of the nine and is quite different from the rest. Note particularly the narrow black tips of the outer primaries, rufous tail, and unique wing shape.

Acknowledgements

The illustrations herein were prepared by Schmitt to help teach raptor identification to personnel of the BNHS raptor ecology project, a collaborative project funded by the U.S. Fish & Wildlife Service. We thank D. Ferguson of the

Raptors with pale bars on upper wings —Identification from above. For explanation see captions (page 3).



Raptors with pale bars on upper wings – Identification from below. For explanation see captions (page 3).

Office of International Affairs, U.S. Fish & Wildlife Service, for arranging our visits to India. We thank the curators and collection managers of the BNHS, India Wildlife Survey, British Museum (Natural History), and U.S. National Museum of Natural History for access to their specimen collections.

Special thanks go to our Indian field companions, Rishad Naoroji and Vibhu Prakash, for showing us Indian raptors. J.C. Daniel and R. Grubh of the BNHS are thanked for support while in India. C. Wilds made many helpful comments on earlier drafts.

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CAPTIONS FOR PLATES

Plate 1. Raptors with pale bars on upperwings —Identification from above.

All nine species have a more or less distinct pale bar across each upperwing. Many also have pale heads. Wing shape and tail shape and pattern are usually the best field marks for identification, but others are helpful. Diagnostic field marks are listed below.

Raptors 1, 2 and 3 have similarly shaped wings.
1. Black kite *Milvus migrans* (adult shown). Long forked tail. 2. Booted eagle *Hieraaetus pennatus.* White 'headlights' at base of forewings; white 'U' on uppertail coverts; rounded, square-cornered tail. 3. Brahminy kite *Haliastur indus* (pale juvenile). Rufous on upperparts, especially primaries; short, unbarred, rounded tail.

Raptors 4, 5 and 6 have pale heads and similarly shaped wings. 4. Crested honey buzzard *Pernis ptilorhyncus* (juvenile). Long, slender neck and head; distinct tail pattern. 5. Crested hawk-eagle (includes juvenile changeable hawk-eagle) *Spizaetus cirrhatus* (juvenile). Rump, as well as uppertail coverts, are pale; distinct tail pattern. (Crest not visible). 6. Crested serpent eagle *Spilornis cheela* (juvenile). Dark cheek patch; bold black and white tail pattern.

7. Bonelli's eagle *Hieraaetus fasciatus* (juvenile). Tail bands indistinct. 8. Short-toed eagle *Circaetus gallicus.* Larger size; larger head; pale bars wider; distinct tail pattern. 9. White-eyed buzzard *Butastur teesa* (juvenile shown). Smaller size; white primary panels; rufous tail.

Plate 2. Raptors with pale bars on upperwings —Identification from below.

All nine species appear quite different from below; underwings; underbody, and undertail patterns and colouratio are the best field marks. Diagnostic field marks are listed below:

1. Black kite *Milvus migrans* (juvenile shown). Dark body and underwing; coverts; pale, banded primary panels; tail squarish when spread. 2. Booted eagle *Hieraaetus pennatus* (rufous morph shown). Rufous body; wide black bands across underwings; pale patch on inner primaries; dark central patch on pale tail. 3. Brahminy kite *Haliast· indus* (pale juvenile). Creamy unbanded primary panel lower body darker than upper body; rounded, unbanded tail.

4. Crested honey buzzard *Pernis ptilorhyncus* (juvenile). Banded dark secondaries; finely streaked underparts; distinct tail pattern. 5. Crested hawk-eagle *Spizaetus cirrhatus* (juvenile). Strongly banded primaries; distinct tail pattern. 6. Crested serpent eagle *Spilornis cheela* (juvenile). Black face patch; heavily streaked breast; rufous underwing coverts; distinct tail pattern.

7. Bonelli's eagle *Hieraaetus fasciatus* (juvenile). Dark wing tips; indistinctly banded dark secondaries; narrow black band across underwing (usually); tail banding indistinct. 8. Short-toed eagle *Circaetus gallicus* (adult shown). Larger size; large head; dark hood (usually); white underwings boldly banded black; distinct tail pattern. 9. White-eyed buzzard *Butastur teesa* (juvenile shown). Smaller size; rufous underwing coverts and lightly banded flight feathers; wide, black throat stripe; rufous tail.

SYSTEMATIC POSITION OF MOLOSSIDAE – AN EMBRYOLOGICAL ANALYSIS[1]

A. Gopalakrishna and N. Badwaik[2]

(With two text-figures)

At present, morphological and anatomical characters constitute the main criteria for classification of eutherian mammals, since other criteria are not available for most mammalian groups. But these systems of classification based on morphological characters, do not necessarily reflect the phylogenetic affinities of various subgroups among mammals. This has been convincingly argued by Mossman (1937, 1953) in his analysis of foetal membrane characters of various grades of eutherian groups. In the absence of adequate data from palaeontology, cytology, genetics, serology and such other disciplines, evidence from embryology assumes considerable significance for determining taxonomic position and phylogenetic affinities among lower grades of taxa, such as Super-families and Families.

So far all taxonomists have placed Pteropodidae at the beginning and Molossidae along with Vespertilionidae within the Super-family Vespertilionidae, at the other end in the taxonomic hierarchy of the Order Chiroptera (Simpson 1945, Ellerman and Morrison-Scott 1951, Honacki *et. al.* 1982, Koopman 1984, Hill and Smith 1985). Jones (1917) examined the anatomy of the female genitalia of many species of bats and suggested that Chiroptera is a polyphyletic group, in which are included members derived from divergent ancestors.

Mossman (1937), basing his conclusions on foetal membrane characters, suggested that Megachiroptera share characters with Rodentia, whereas Microchiroptera are closer to Insectivora. It must, however, be conceded that very little information was available about the embryology of most families of Microchiroptera at that time. Moghe (1951), in his study of the embryology of *Pteropus giganteus giganteus*, mentioned, "the two groups (Megachiroptera and Microchiroptera) are widely separated from each other in a large number of other characters and probably represent independent offshoots from some primitive insectivore". (Parentheses ours.) On the basis of embryological characters of four microchiropteran families, Gopalakrishna (1958) mentioned, "the Megachiroptera and Microchiroptera are not as divergent as formerly believed. Many similarities and transitional characters are now apparent between the two sub-orders".

Luckett (1979), making an analysis of anatomical and embryological characters, suggested that the group Chiroptera is monophyletic, but he placed Molossidae as far removed from Pteropodidae. Gopalakrishna and co-workers (1981, 1983, 1987, 1988, 1989) examined the anatomy of the female genitalia, blastocyst-uterus relationship and development of foetal membranes of several families of bats, and postulated that not only is Chiroptera a monophyletic group but that the taxonomic hierarchy currently maintained by systematists needs some changes. One such suggestion was that the systematic position of Molossidae needs to be re-examined.

The basic premise for the present report is that in eutherian mammals embryological characters are far more conservative than are morphological characters, since development takes place in a constant environment within the uterus, while morphological characters are directly influenced by the environment and are therefore adaptive. Hence, similarities in embryological characters, according to Mossman (1937, 1953), indicate a closer phylogenetic affinity than similarities in morphological characters.

The present report is based on recent publications and ongoing work in this laboratory on the embryology of four molossid species, namely *Chaerephon plicata* (Gopalakrishna *et al.* 1989),

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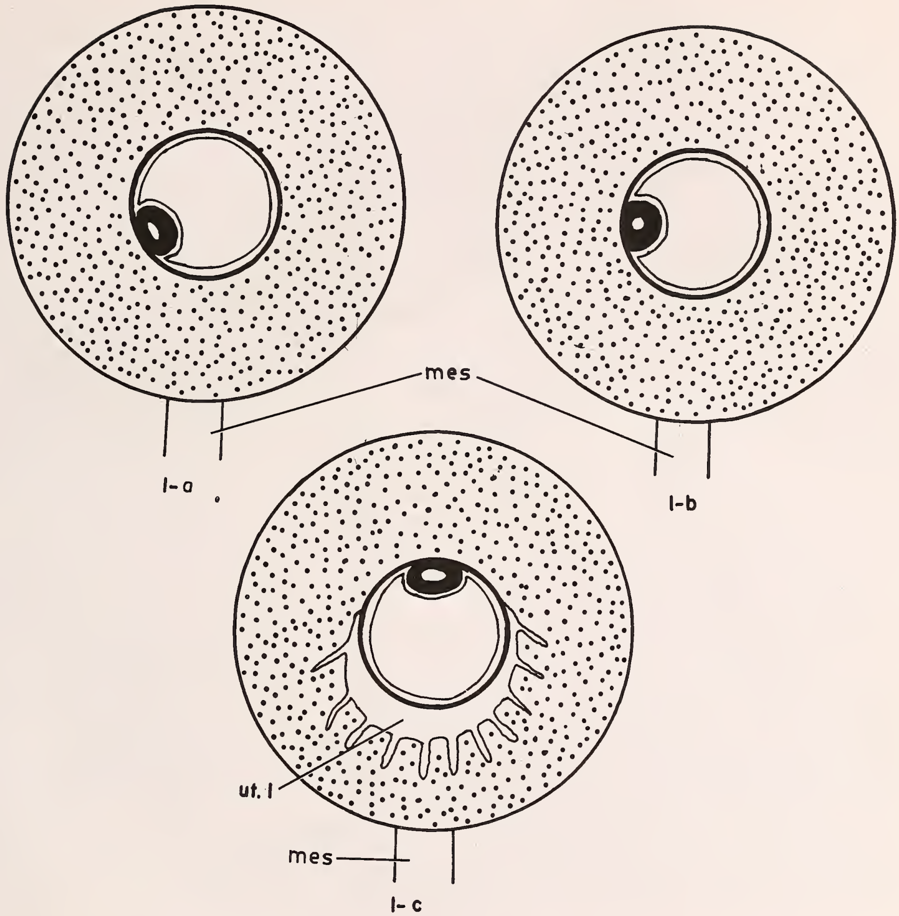

Fig. 1. a-c. Uterus-blastocyst relationship at the time of implantation in (a) Pteropodidae, (b) Molossidae and (c) Vespertilionidae. The dark circle with a white central area represents the embryonic mass containing the primitive amniotic cavity. mes : mesometrium; ut. l : uterine lumen.

Tadarida aegyptiaca (Sandhu 1986), *Tadarida trageta* and *Molossus major aztecus* (*M. molossus*) (Gopalakrishna and Badwaik in press) and comparing the results with what is known of the embryology of other relevant families, namely Pteropodidae and Vespertilionidae.

Such a comparison reveals that the molossids share more embryological characters with pteropodids than with vespertilionids. Among pteropodids, implantation of the blastocyst is partly interstitial with the embryonic mass oriented towards the lateral side in *Pteropus giganteus* (Moghe 1951). In *Rousettus leschenaulti* (Karim 1976) and *Cynopterus sphinx* (pers. obs.) blastocyst implantation is superficial and the embryonic mass is oriented towards the tubo-uterine junction, which is sub-terminal and towards the lateral side of the uterus. The orientation of the embryonic mass in the implanting blastocyst is lateral in all the molossid bats (Sansom 1932, Pendharkar and Gopalakrishna 1983, Sandhu 1986).

Secondly, in Pteropodids and all molossids the blastocyst establishes contact with the uterine

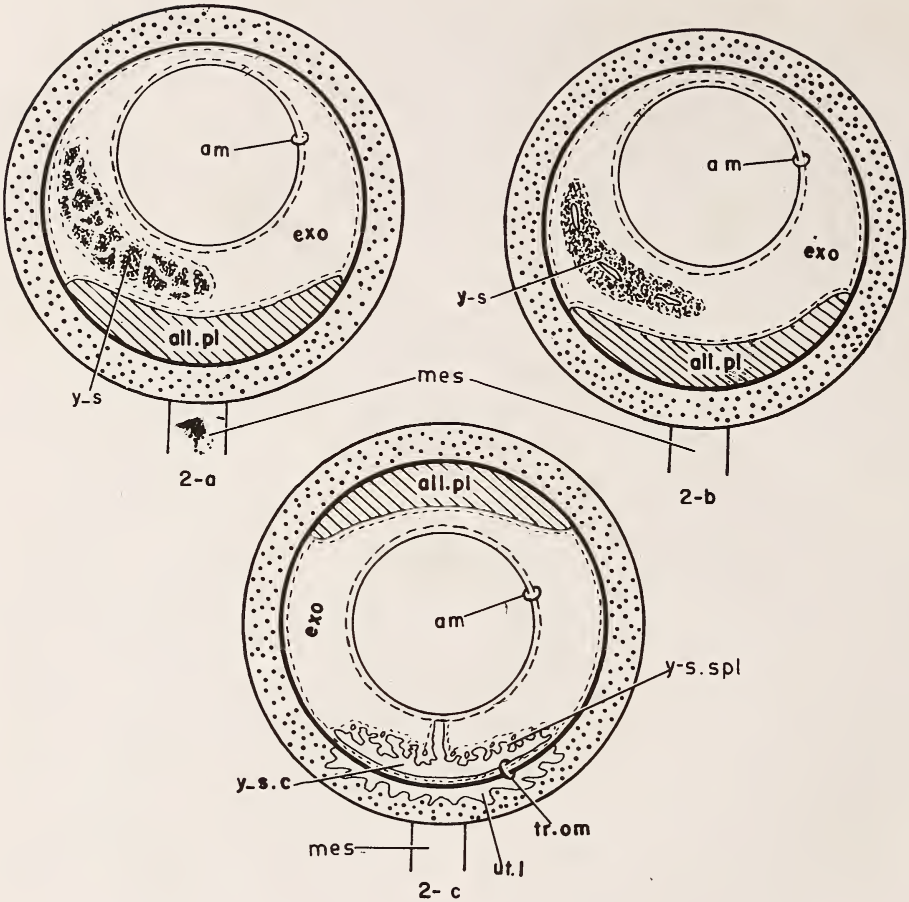

Fig. 2a-c. Definitive arrangement of foetal membranes in (a) Pteropodidae, (b) Molossidae and (c) Vespertilionidae
all. pl : allantoic placenta; am: amnion; exo: exocoelom; tr. om: trilaminar omphalopleure; y-s: yolk sac; y-s.c.: yolk sac cavity; y-s. spl: yolk sac splanchnopleure. Other legends as in Fig. 1.

wall on all sides, resulting in the obliteration of the uterine lumen at the level of implantation. This situation differs from what obtains in all vespertilionids, in which the blastocyst attaches itself to the antimesometrial side of the uterus by its embryonic pole, and the abembryonic region of the wall of the blastocyst lies freely hanging into the uterine lumen on the mesometrial side of the uterus (Fig. la-c).

In both Pteropodidae and Molossidae an extensive yolk sac placenta is formed on all sides of the uterus except where the embryonic plate intervenes between the yolk sac and the uterine wall. This is at first non-vascular, but soon becomes vascularised and forms the chorio-vitelline placenta during early stages of pregnancy. In Vespertilionidae, on the other hand, only the lateral wall of the yolk sac forms the yolk sac placenta, while the abembryonic region remains non-vascular and free.

The unique modification of the yolk sac into a solid gland-like structure in both Pteropodidae (van der Sprenkel 1932, Moghe 1951, 1956; Wimsatt 1954, Gopalakrishna and Karim 1974,

Karim *et. al.* 1979, Gopalakrishna and Karim 1981) and Molossidae (Stephens 1962, Stephens and Easterbrook 1968, 1969, 1971; Sandhu 1986, Gopalakrishna *et al.* 1989) is unmatched in any other family of Chiroptera – and in fact in any other mammal. The yolk sac splanchnopleure becomes free and undergoes progressive collapse until the yolk sac lumen is completely obliterated in Pteropodidae. In Molossidae the yolk sac lumen is reduced to a few isolated, very narrow streak-like spaces here and there within the solid yolk sac.

In both families the endodermal cells undergo enormous hypertrophy and form acinus-like groups; the mesodermal cells form the loose matrix and the outer covering to the gland-like yolk sac. In Vespertilionidae (Ramaswami 1933, Wimsatt 1945, Enders and Wimsatt 1968, Gopalakrishna 1950, Gopalakrishna and Sapkal 1974 Ramakrishna and Madhavan 1977, Gopalakrishna *et al.* in press) the yolk sac lumen persists as a continuous space between the proximal invaginated, folded vascular splanchnopleure and the distal free trilaminar omphalopleure (Fig. 2a-c). The uterine lumen persists on the mesometrial aspect of the uterus throughout gestation.

The definitive allantoic placental disc is mesometrial in both Pteropodidae and Molossidae, whereas it is squarely antimesometrial in Vespertilionidae (Fig. 2a-c). With respect to the histological structure, the placenta is endotheliochorial in *Pteropus* and *Cynopterus* and haemochorial in *Rousettus*. In molossids a diffuse endotheliochorial chorio-allantoic placenta occurs concurrently with a small mesometrially located discoid placenta until about the third quarter of gestation. The discoid placenta is haemochorial. However, during the final quarter of gestation the diffuse endotheliochorial allantoic placenta disappears, and only the mesometrially located discoid haemochorial placenta persists. Molossid bats, therefore, develop both endotheliochorial and haemochorial allantoic placentae. In all vespertilionids the placenta is haemochorial.

It is thus evident that embryological similarities between Molossidae and Pteropodidae and differences between Molossidae and Vespertilionidae suggest a closer relationship between Pteropodidae and Molossidae than between Molossidae and Vespertilionidae. It is, therefore, suggested on purely embryological grounds that Molossidae be separated from the Super-family Vespertilionidae and be placed somewhere between Pteropodidae and Emballonuridae.

We thank the U.G.C. and the C.S.I.R., New Delhi for financial assistance for carrying out this work.

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A STUDY OF THE FOOD HABITS OF SIX ANURAN TADPOLES[1]

A.G. SEKAR[2]

(With two text-figures)

The intestinal contents of tadpoles of six anuran species, collected from different waterbodies, were studied to find out their food in natural habitat. The gut contents revealed that all the tadpoles studied were largely herbivorous and ingested 36 genera of algae. The food is apparently determined by the nature of the habitat. It seems that in nature the tadpoles studied fed randomly, without any discrimination. The existing literature indicates that these tadpoles have the capacity to adjust their feeding habits to available food in new environments.

INTRODUCTION

All adult amphibians are carnivorous and devour whatever they can overcome, such as crustacea, small fishes, worms and insects. Tadpoles, on the other hand, are largely herbivorous (Cunningham 1912). They are fundamentally specialised for suspension feeding (Wassersug 1975) and depend mainly on algae for their food in natural habitats. The laboratory food for tadpoles as suggested by McCann (1932) was raw meat and also aquatic plants like *Hydrilla, Ceratophyllum, Lemna* and *Vallisneria*.

The dietary habits of tadpoles have been studied by Kamat (1962), Sabnis and Kolhatkar (1977), Sabnis and Kuthe (1980) and Wassersug *et al.* (1981). Sabnis and Kuthe examined the natural food of tadpoles of *Bufo melanostictus* by gut analysis. Wassersug *et al.* described the tadpoles of *Philautus* sp. in Thailand as macrophagus, feeding on frog eggs. Literature on natural food of tadpoles is meagre, whereas there is fairly adequate information on the diet of adult frogs (Andrews 1979, Davidson 1916, Isaac and Rege 1975, Joshee 1968, Mohanty-Hejmadi and Acharya 1982, Rangaswamy and Channabasavanna 1972).

The present study examines the dietary components of tadpoles of *Bufo melanostictus* (Family Bufonidae), *Ramanella montana* (Microhylidae), *Rana tigerina, Rana limnocharis, Tomopterna breviceps* (Ranidae) and *Polypedates maculatus* (Rhacophoridae) in nature.

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MATERIAL AND METHODS

Tadpoles were collected from various waterbodies like pools, river, cisterns and ponds in Sanjay Gandhi National Park in Borivli, Bombay (18° 55'N, 72° 54'E) during the monsoon of 1983. The tadpoles were collected with a net and preserved in 10% formalin. In the laboratory they were sorted out into pre-hindlimb and hindlimb stages.

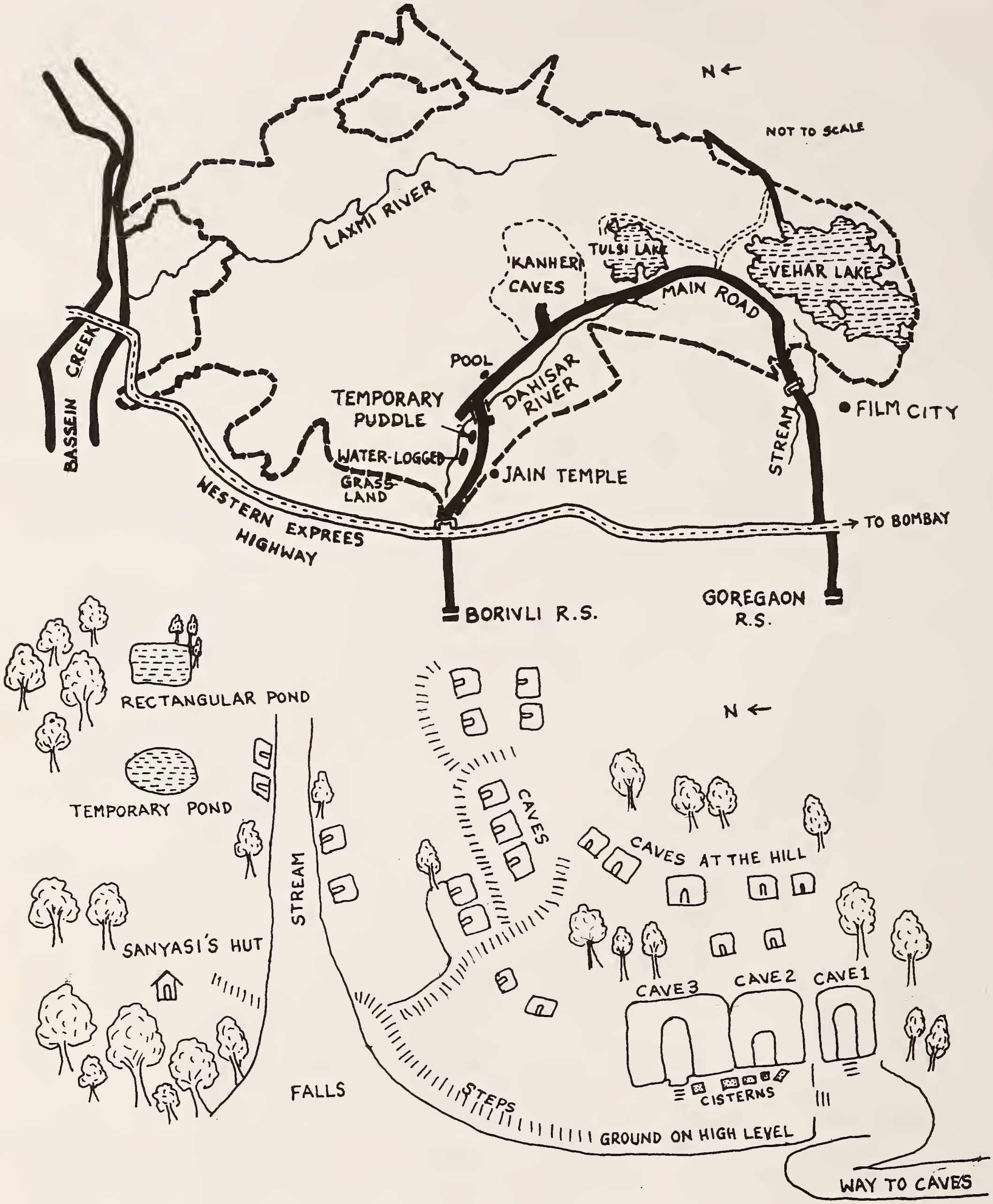
To study the gut content, the intestine was removed, squashed in a small petri-dish and liquefied by adding 5 ml of water. The fragments of empty intestine were removed and the liquid gut content was analysed under a 320 x microscope. The algal materials were identified and counted in viewing area of 0.732 sq. mm. Five similar squares were counted for algal components, and the average taken. Ten tadpoles per stage were examined.

Tadpoles of different species were collected from the following waterbodies (Figs. 1, 2).

(1) *Bufo melanostictus*: Dahisar river and a small stream near Film City. (2) *Ramanella montana*: Dahisar river and roadside pool. (3) *Rana tigerina*: Pond near Jain temple and rectangular pond at Kanheri Hill. (4) *Rana limnocharis*: Temporary puddle and water-logged grassland. (5) *Tomopterna breviceps*: Dahisar river and corridor of Kanheri cave No.1 with 5 cm depth of still water. (6) *Polypedates maculatus*: Pool near Sanyasi's hut and temporary puddle.

RESULTS AND DISCUSSION

The data on food items in the gut of six tadpole species are shown in Tables 1-6. All six



Figs. 1-2. Location of collection sites of tadpoles at Sanjay Gandhi National Park and Kanheri Caves.

TABLE 1
PERCENTAGE OF FOOD ITEMS IN THE GUT OF TADPOLES OF *Bufo melanostictus*

Intestinal contents	Dahisar river		Stream near Film City	
	Pre-hindlimb stage	Hindlimb stage	Pre -hindlimb stage	Hindlimb stage
Oscillatoria	1.06	6.19	9.73	2.26
Scenedesmus	–	–	–	0.75
Phacus	0.30	–	0.54	–
Oedogonium	0.04	–	–	–
Closterium	0.23	–	–	–
Cosmarium	3.26	1.03	–	–
Pinnularia	74.17	63.92	74.05	47.10
Navicula	17.73	21.65	12.97	13.85
Cymbella	2.35	2.06	1.08	–
Synedra	0.76	3.09	–	32.49
Stauroneis	–	–	–	3.02
Euchalanis	–	–	1.08	–
Nematode worm	–	2.06	0.54	0.25

TABLE 2
PERCENTAGE OF FOOD ITEMS IN THE GUT OF TADPOLES OF *Ramanella montana*

Intestinal contents	Dahisar river		Roadside pool	
	Pre-hindlimb stage	Hindlimb stage	Pre-hindlimb stage	Hindlimb stage
Oscillatoria	0.21	0.33	–	–
Spaerella	–	–	–	15.62
Oedogonium	–	–	9.37	–
Cosmarium	0.85	1.76	–	–
Vaucheria	–	–	3.13	6.25
Pinnularia	98.50	97.23	56.25	43.75
Navicula	0.43	0.66	12.50	12.50
Spores	–	–	18.75	18.75
Daphnia	–	–	–	3.15

tadpoles were largely herbivorous; 36 genera of algae and four species of animalcules were recorded from the stomach contents. The intestines were long and spirally coiled like a watch-spring. Noble (1931) stated that the more carnivorous tadpoles have a shorter digestive tract than herbivorous species.

Wassersug (1975) reported that the unique morphology of tadpoles is in some way associated with herbivory, plankton feeding, filter feeding, suspension feeding etc. The elongated, coiled intestines of most tadpoles contrast sharply with the shortened digestive tract of the few known carnivorous, non-feeding, or direct developing forms.

Food items of tadpoles collected from running water differed from those collected from still water. For example the food of *Bufo melanostictus* tadpoles collected from Dahisar river as well as from the stream near Film City gate varied and certain food items like *Eudorina, Opalina, Spirogyra, Ulothrix, Euglena*, watermites and

TABLE 3
PERCENTAGE OF FOOD ITEMS IN THE GUT OF TADPOLES OF *Rana tigerina*

Intestinal contents	Pond near Jain temple		Rectangular pond at Kanheri Hills	
	Pre-hindlimb stage	Hindlimb stage	Pre-hindlimb stage	Hindlimb stage
Oscillatoria	7.48	1.51	0.04	0.14
Spirulina	–	–	1.56	0.38
Scytonema	–	–	0.09	0.13
Eudorina	–	7.09	1.95	1.78
Pediastrum	2.04	3.92	–	–
Ankistrodesmus	–	5.13	–	–
Selenastrum	–	–	11.64	12.94
Tetraedron	–	2.57	0.58	1.95
Scenedesmus	34.69	12.08	77.83	81.09
Ulothrix	–	–	0.24	0.23
Phacus	2.72	28.70	0.44	0.51
Oedogonium	0.68	0.90	0.14	0.10
Closterium	–	3.63	–	–
Euastrum	–	0.15	–	–
Cosmarium	–	–	0.04	0.10
Pinnularia	26.53	22.96	0.29	0.31
Navicula	3.40	0.75	0.44	0.23
Spores	21.76	8.00	4.45	0.38
Monostyla	–	–	–	0.07
Nematode worm	0.68	2.26	–	–
Daphnia	–	0.15	0.19	–
Tardigrada	–	0.15	–	–

Pleurococcus were absent. However, Sabnis and Kuthe (1980) have reported these food items in *B. melanostictus* collected from a pond.

Similarly, tadpoles of *Tomopterna breviceps* obtained from Dahisar river had eaten only a few varieties of food items, whereas tadpoles of the same species collected from still water in the corridor of Kanheri Cave 1 had consumed more food items. The food is apparently determined by the nature of the habitat. Running water, generally, contains less microfauna than ponds and puddles. Tonapi (1980) also noted the conspicuous absence of many rooted plants and the relative absence of plankton in running water. But tadpoles of *Ramanella montana* had fed on a limited number of food items though they were collected from stagnant water (rain pool). This might be due to the nature of the pool (fresh and muddy water, with meagre algal components).

The food items differed for different locations, even for the same species of tadpole. *Oedogonium, Closterium* and *Cosmarium* were found in *Bufo melanostictus* tadpoles of Dahisar river but not in tadpoles from the stream near Film City. In *Rana tigerina* tadpoles, *Scenedesmus* was noticed both from the pond near Jain temple and the rectangular pond at Kanheri caves. However, there were several differences in food items from *tigerina* tadpoles from these two locations – *Spirulina, Scytonema, Selenastrum, Ulothrix, Cosmarium* and *Monostyla* were found in Kanheri caves tadpoles, but not in Jain temple tadpoles. There are similar location-related differences in the case of other species also.

From this data it seems that tadpoles feed randomly without any discrimination, on whatever is available in the particular waterbody where they grow up. Costa and Balasubramanium

TABLE 4
PERCENTAGE OF FOOD ITEMS IN THE GUT OF TADPOLES OF *Rana limnocharis*

Intestinal contents	Temporary puddle		Waterlogged grassland	
	Pre hindlimb stage	Hindlimb stage	Pre hindlimb stage	Hindlimb stage
Oscillatoria	0.93	2.38	0.26	1.00
Spirulina	–	–	0.52	0.25
Lyngbya	1.85	1.70	3.65	3.72
Anabaena	0.93	0.68	–	–
Scytonema	–	–	0.52	0.50
Tolypothrix	1.39	1.36	–	–
Sphaerella	2.78	3.40	1.30	1.49
Oocystis	–	–	3.65	3.22
Ankistrodesmus	–	–	0.52	0.25
Scenedesmus	4.17	0.34	–	–
Oedogonium	5.55	4.08	1.04	1.00
Phacus	2.31	1.20	–	–
Zygnema	–	–	0.26	0.25
Closterium	11.11	8.84	3.65	4.96
Pleurotaneum	–	–	2.08	1.00
Euastrum	1.38	1.70	5.73	5.46
Microsterias	–	–	1.30	0.25
Cosmarium	26.85	15.99	13.54	18.11
Staurastrum	3.70	2.38	2.60	3.47
Onychonema	–	0.34	9.11	7.20
Desmidium	–	0.34	3.13	6.20
Pinnularia	24.07	41.84	33.59	30.52
Navicula	12.04	10.20	7.55	6.70
Cymbella	0.93	2.72	5.20	3.72
Synedra	–	0.68	–	–
Monostyla	–	–	0.52	0.25
Daphnia	–	–	0.26	0.25

(1965) showed from stomach content analyses that *Rhacophorus cruciger* larvae are qualitatively non-discriminant in the food that they ingest. Similar analyses for *Rana clamitans* tadpoles showed that these larvae are qualitatively and quantitatively non-discriminant in their suspension feeding (Farlowe 1928). But, controversially, Kamat (1962) reported that tadpoles did not feed on all available algae. He found in the laboratory that tadpoles did not feed on certain algae like *Chara, Cladophora, Pithophora*. However, more work is required to prove that tadpoles show food preferences in natural environment.

Some diatoms (*Pinnularia, Navicula, Scenedesmus, Closterium, Cosmarium*) which are suspended in the water, were found in the present study to have been fed on in good percentage. Presumably, these were abundant in that particular period and were therefore taken by the tadpoles. Wassersug (op. cit.) stated that tadpoles are highly specialised suspension feeders, adapted for utilizing rapid increases in primary production of a food source. Such sources are probably coupled to environmental fluctuations and available for only a limited amount of time during any year.

TABLE 5
PERCENTAGE OF FOOD ITEMS IN THE GUT OF TADPOLES OF *Tomopterna breviceps*

Intestinal contents	Dahisar river		Corridor of Cave 1 at Kanheri	
	Pre-hindlimb stage	Hindlimb stage	Pre-hindlimb stage	Hindlimb stage
Gloeocapsa	0.63	–	1.70	5.65
Oscillatoria	21.65	19.59	19.57	17.39
Spirulina	–	–	6.80	1.74
Lyngbya	–	–	2.55	0.87
Scytonema	–	–	25.95	15.21
Oedogonium	1.91	0.50	5.95	1.74
Phacus	–	–	0.85	1.30
Closterium	–	–	–	0.43
Cosmarium	–	–	4.25	1.74
Spirogyra	2.54	2.51	–	–
Pinnularia	22.29	32.16	8.08	8.69
Navicula	37.57	32.66	3.40	8.69
Cymbella	–	–	1.70	1.30
Synedra	12.10	11.05	–	1.74
Spores	–	–	17.87	32.17
Nematode worms	1.70	1.50	0.43	1.30
Tardigrada	–	–	0.85	–

McCann (1932) suggested raw meat as a food for tadpoles reared in the laboratory. Sekar (1990) fed tadpoles of the Malabar gliding frog *Rhacophorus malabaricus* with earthworms, meat and snail flesh in the laboratory to rear them. These non-algal food items were readily accepted.

Wassersug *et al.* (1981) reported that the larvae of *Theloderma stellatum* (Rhacophoridae) of Thailand, which developed in tree holes containing decomposing leaves, fed on amoeba tests, fungal spores, lepidopteran scales etc.

In contrast, tadpoles of *Philautus* sp., which developed in a tree hole containing less than 75 ml of water without any indirect source of food, appear to rely on introduced frog eggs for food. It seems that tadpoles might have the capacity to adapt to a new environment and adjust to feeding on the food available in that environment.

There was notably no difference between the pre-hindlimb and hindlimb stages; food items were similar in both stages.

CONCLUSIONS

Gut analysis of six species of tadpoles led to the following conclusions.

(1) All the tadpoles studied were largely herbivorous in food habits; a variety of algal components constituted the major food items. (2) Tadpoles from still water fed on more food items than those obtained from running water. (3) In nature, the tadpoles studied fed randomly, without any qualitative discrimination. (4) Tadpoles which are fundamentally specialised for suspension feeding fed more on diatoms like *Pinnularia, Navicula, Cosmarium* etc. (5) Food items were almost similar in both pre-hind limb and hindlimb stages.

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TABLE 6
PERCENTAGE OF FOOD ITEMS IN THE GUTS OF TADPOLES OF *Polypedates maculatus*

Intestinal contents	Pool near Sanyasi's hut		Temporary puddle	
	Pre-hindlimb stage	Hindlimb stage	Pre-hindlimb stage	Hindlimb stage
Gloeocapsa	–	–	1.01	–
Oscillatoria	4.79	6.61	2.53	0.39
Lyngbya	–	–	1.01	0.39
Sphaerella	2.17	3.78	4.04	1.76
Ankistrodesmus	0.09	–	–	–
Scenedesmus	3.44	3.78	7.07	5.69
Ulothrix	–	–	0.25	0.19
Oedogonium	16.00	17.12	2.77	0.76
Phacus	7.78	6.85	0.76	0.19
Spirogyra	–	–	2.70	1.96
Closterium	2.44	1.18	–	–
Pleurotaenium	–	–	0.25	–
Euastrum	–	–	1.26	0.98
Microsterias	–	–	0.76	–
Cosmarium	23.32	12.87	20.96	26.93
Staurastrum	2.99	2.72	1.76	2.95
Pinnularia	8.41	6.14	28.03	18.86
Navicula	14.92	10.86	6.31	18.23
Cymbella	–	–	3.03	2.16
Synedra	–	–	8.33	2.16
Calonies	–	–	4.55	13.75
Spores	13.38	27.74	–	–
Monostyla	0.27	–	0.76	0.98
Nematode worms	–	–	0.25	0.19
Daphnia	–	0.35	–	–
Unidentified	–	–	1.76	0.58

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I. CLADOCERA OF KEOLADEO NATIONAL PARK, BHARATPUR, AND ITS ENVIRONS[1]

K. VENKATARAMAN[2]

(With forty-nine text-figures)

A study made on collections of zooplankton from shallow waters and ponds in and around Keoladeo National Park, Bharatpur, yielded 39 species of Cladocera, of which 25 are recorded for the first time from Rajasthan. Some selected species recorded in the present study are illustrated and described.

INTRODUCTION

Very little is known regarding the occurrence of different species of Cladocera in Rajasthan, particularly the Keoladeo National Park, which has a wide range of freshwater habitats and attracts various migratory birds from different parts of the world. The important earlier works on Cladocera of Rajasthan are those of Biswas (1964), Nayar (1971) and Venkataraman (1988, 1990). Ali and Vijayan (1983) studied the general limnology, primary productivity and secondary productivity in Keoladeo National Park. There are also some records of the protozoan species (Mahajan *et al.* 1980a), benthic fauna (Mahajan *et al.* 1980b) and dynamics of zooplankton (Mahajan *et al.* 1980c) made in freshwater habitats of the Keoladeo National Park (KNP).

The material for the present study was collected periodically from eight different places in the Park and 30 ponds and ditches of Rajasthan. The collections revealed 39 species of Cladocera, of which 25 are new records to Keoladeo National Park and Rajasthan. Short description including illustration of diagnostic features of a few interesting species is given in this paper. The impact of introduced fauna is also discussed.

MATERIAL AND METHODS

591 zooplankton samples were collected during the years 1984-85 from littoral and limnetic regions of freshwater habitats of Keoladeo National Park (27° 7.6′ to 27° 12.2′ N, 77° 29.5′ to 77° 39.9′ E) and roadside ponds and ditches in and around Bharatpur, Rajasthan. The collections were made with 80 μm mesh size plankton nets of 30 cm upper diameter by taking both vertical and horizontal hauls. All samples were examined with a binocular microscope and the species were separated. Temporary slides were made in glycerine for confirming diagnosis. Drawings were made with a camera lucida and the measurements taken using a calibrated ocular micrometer. A list of species recorded is given in Table 1.

KNP has a wide range of freshwater habitats. About 10% of the land is covered with water that comes from a reservoir during the rainy season. This reservoir receives and retains faunal elements from flowing and standing waters used for irrigation via Gambir and Banganga rivers. The climate is subtropical and temperate, with 1200 mm annual rainfall. There were 120 rainy days in the year June 1984 to May 1985. The mean annual temperature was 22°C; the lowest temperature (3°C) was recorded on 14 January and the highest (42°C) on 27 July 1984.

DESCRIPTION OF FEMALES OF SELECTED SPECIES

Pseudosida bidentata Herrick, 1884 (Figs. 1-2)

Size: 1.20 mm. Body elongated oval; head short; eye relatively small and situated near antero-ventral corner. Antennules unsegmented, long and attached to postero-ventral part of head. Antenna not extending beyond posterior margin of valves. Ventral margin with a series of long setae followed by a series of spinules on postero-ventral corner. Postabdomen short and broad. Lateral side with 10 groups of spines. Claw long, curved dorsally; convex surface serrated; concave surface with series of short setules and three basal

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TABLE 1
LIST OF CLADOCERA RECORDED FROM KEOLADEO NATIONAL PARK AND ITS ENVIRONS

Family Sididae	
*1.	*Pseudosida bidentata* Richard
*2.	*Latonopsis australis* Sars
3.	*Diaphanosoma excisum* Sars
*4.	*Diaphanosoma sarsi* Richard
*5.	*Diaphanosoma senegalensis* (Gauthier)
Family Daphnidae	
6.	*Daphnia similis* Claus
*7.	*Daphnia longispina* Muller
8.	*Daphnia lumholtzi* Sars
9.	*Simocephalus vetulus elizabethae* (King)
*10.	*Simocephalus acutirostratus* Sars
11.	*Ceriodaphnia cornuta* Sars
12.	*Ceriodaphnia reticulata* (Jurine)
13.	*Scapholeberis kingi* Sars
Family Macrothricidae	
14.	*Ilyocryptus spinifer* Herrick
15.	*Macrothrix spinosa* King
16.	*Macrothrix triserialis* (Brady)
*17.	*Grimaldina brazzai* Richard
*18.	*Guernella raphalis* Richard
Family Moinidae	
19.	*Moina micrura* Kurz
*20.	*Moinodaphnia macleayii* Richard
Family Bosminidae	
*21.	*Bosminopsis deitersi* Richard
Family Chydoridae	
*22.	*Alona costata* Sars
*23.	*Alona davidi* Richard
*24.	*Alona monacantha* Sars
*25.	*Alona karua* King
26.	*Alona verrucosa* Sars
*27.	*Camptocercus australis* Sars
28.	*Chydorus eurynotus* Sars
*29.	*Chydorus parvus* Daday
*30.	*Chydorus ventricosus* Daday
*31.	*Dadaya macrops* (Daday)
*32.	*Dunhevedia crassa* King
*33.	*Euryalona orientalis* (Daday)
*34.	*Kurzia longirostris* (Daday)
*35.	*Leydigia australis* Sars
36.	*Leydigia acanthocercoides* (Fischer)
*37.	*Indialona ganapati* Petkovski
*38.	*Oxyurella sinhalensis* (Daday)
*39.	*Pluroxus similis* Vavra

* New records

spines. Occurs in all types of habitat except in turbid ponds.

Latonopsis australis Sars, 1888 (Figs. 3-4)

Size: 1.15 mm. Body oblong. Head short and indistinctly separated from the body. Eye small, situated near antero-dorsal end of head. Ocellus small and situated near base of labrum. Antennules long and segmented, attached to antero-ventral corner of head. Valves slightly convex dorsally and broadly rounded ventrally. Ventral margin with a series of long setae. Postabdomen short without anal denticles, lateral surface with a series of 8-10 denticles. Claw curved dorsally with two long basal spines. Occurs in all types of habitat except in turbid ponds.

Diaphanosoma excisum Sars, 1885 (Figs. 5-6)

Size: 1.05 mm. Head large and rounded anteriorly. Eye small. Postero-ventral corner broadly rounded with 5-9 marginal denticles followed by a series of fine setules. Claw serrated on the distal convex surface; concave surface with three long basal spines.

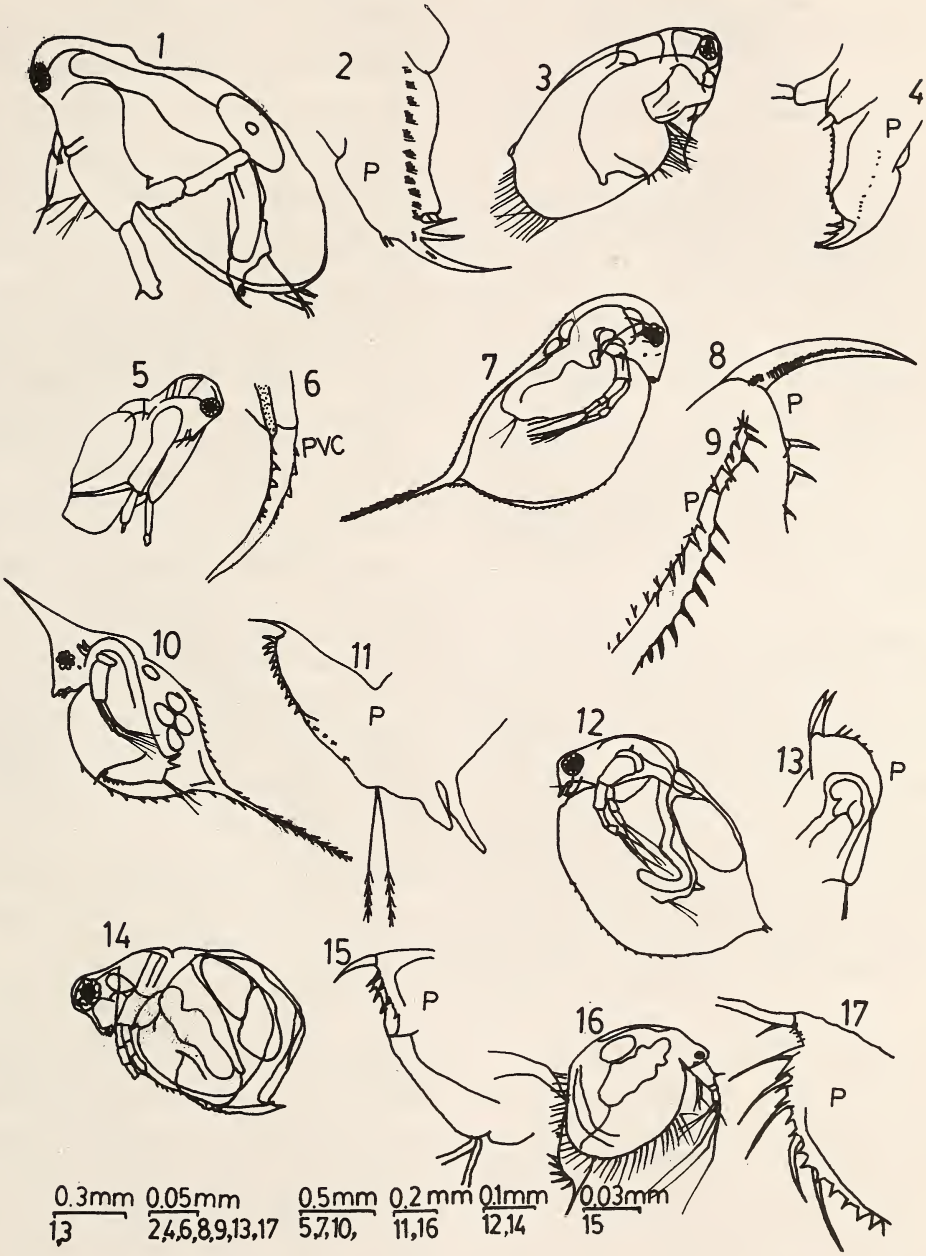
Very common. Occurs in all types of habitat except in marshes. This species has already been recorded in Rajasthan (Biswas 1971, Nayar 1971).

Daphnia similis Claus, 1876 (Figs. 7-9).

Size: 2.25 mm. Body slightly compressed, elliptical in shape. Head rounded anteriorly, rostrum pointed ventrally; antennules short, attached to posterior margin of rostrum. Eye large, situated slightly closer to the antero-ventral margin of the head. Valves with a series of spinules on dorsal and ventral margins. Postabdomen narrow distally with about nine pointed denticles. Rare. Occurs only in turbid ponds of Bharatpur.

Daphnia lumholtzi Sars, 1885 (Figs. 10-11)

Size: 1.52 mm. Head with pointed helmet. Rostrum small, fornix well developed. Body rounded. Dorsal and ventral margins with a series of spines. Postabdomen long and narrow with 9-11 denticles on the dorsal side.



Figs. 1–17. Cladocera of Keoladeo National Park and environs (females). P– postabdomen; PVC– postero-ventral corner. 1-2. *Pseudosida bidentata*; 3-4. *Latonopsis australis*; 5-6. *Diaphanosoma excisum*; 7-9. *Daphnia similis*; 10-11. *D. lumholtzi*; 12-13. *Ceriodaphnia cornuta*; 14-15. *Scapholeberis kingi*; 16-17. *Ilyocryptus spinifer.*

This is the commonest *Daphnia* sp. in the limnetic region of aquatic habitat of KNP. It has been already reported in Rajasthan (Biswas 1971, Nayar 1971).

Ceriodaphnia cornuta Sars, 1885 (Figs. 12-13)

Size: 0.39 mm. Head depressed and separated from the carapace by a dorsal impression. Antennules short and broad, with a long seta and a group of sensory setae on the apex. Eye large, ocellus absent. Postero-dorsal corner of the carapace with two acute and diverging points. Postabdomen with four or five curved denticles. Claw long, gently curved with a series of setules along the concave surface.

Very common. Occurs in all types of habitat, especially shallow ponds of KNP. Both horned and hornless individuals are found together with *Diaphanosoma excisum* and *Moina micrura*. This species has already been recorded in Rajasthan (Nayar 1971).

Scapholeberis kingi Sars, 1903 (Figs. 14-15)

Size: 0.59 mm. Body rounded dorsally. Head small and slightly depressed, rostrum rounded and projecting ventrally. Eye large, ocellus small, situated closer to the rostrum than to the eye. Valves with lines and reticulations; posterior ventral margin has a long denticle. Postabdomen broad, dorsal margin with five or six denticles. Claw curved dorsally, with spinules along the concave surface. Common in all types of habitat but never occurs in large numbers.

Ilyocryptus spinifer Herrick, 1882 (Figs. 16-17)

Size: 0.75 mm. Body oval. Head small. Eye large, ocellus small, situated about halfway between eye and base of antennules. Antennules long with a group of sensory setae on distal end. Valves with a series of long feather-like setae on ventral side. Postabdomen with slight depression in the middle. Preanal margin with eight marginal denticles, postanal margin with 12 denticles up to anal groove and with five long and stout spines on the lateral surface. Claw with two basal spines. Three spinules present in between the base of claw. Common. Occurs in small numbers in marshes of KNP and in the other areas in and around Bharatpur.

Macrothrix spinosa King, 1852 (Figs. 18-19)

Size: 0.41 mm. Body round-oval; dorsal margin serrated. Head rounded, ventral margin slightly concave with slightly pointed antero-ventral corner. Antennules short, with a long seta near its base. Eye large, ocellus small and situated much nearer to the base of antennules than to the eye. Postabdomen broadly rounded. Claw short and serrated on the concave surface.

Very common. Occurs in all types of habitat in KNP and in the Bharatpur ponds.

Macrothrix triserialis Brady, 1886 (Figs. 20-21).

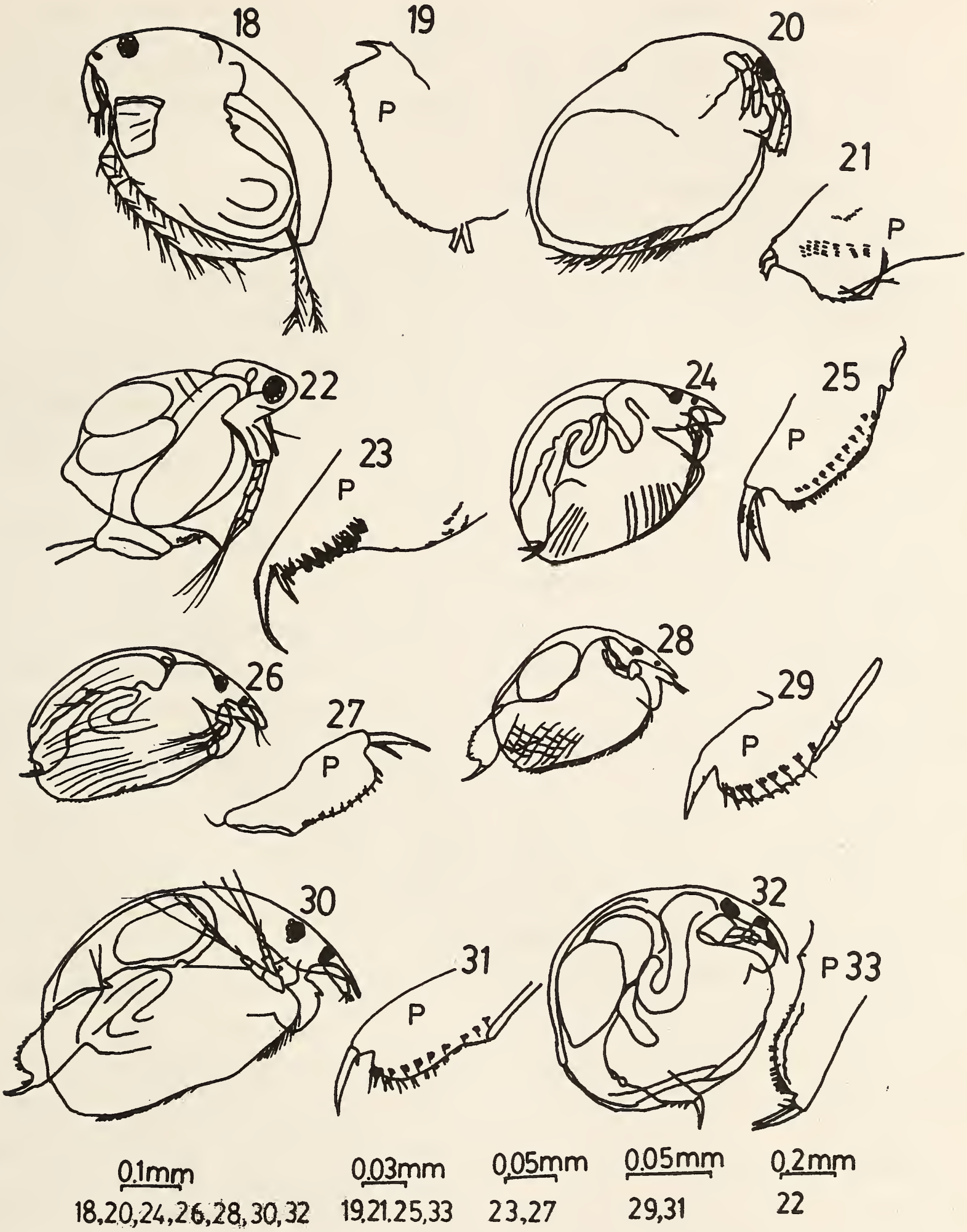
Size: 0.56 mm. Body oval, dorsal margin with a slight cervical depression. Head with a round projection on anterior margin above eye. Eye large, ocellus small and situated nearer apex of rostrum than eye. Antennules long with a long lateral seta. Antennae short with the longest seta having two or three larger spines in the middle. Ventral margin of the valve with a series of long setae in groups of three. Postabdomen bilobed with rows of spines increasing in size proximally. Claw short and serrated without basal spine.

Very common. Occurs in all the marshes of KNP and in the ponds of Bharatpur.

Grimaldina brazzai Richard, 1892

Size: 0.87 mm. Body quadrangular-oval. Head small, eye large. Ocellus small and situated closer to apex of rostrum than to eye. Antennules long and slightly segmented. Postabdomen bilobed with broadly rounded preanal margin. Postanal margin with two groups of long spines. Preanal corner with 2 large spines followed by a series of short spinules proximally. Claw long with basal spines.

Rare. Only a few specimens occurred in marshes of KNP. It has already been recorded by Venkataraman (1990).



Figs. 18-33. Cladocera of Keoladeo National Park and its environs, (females). P – postabdomen.
18-19. *Macrothrix spinosa*; 20-21. *M. triserialis*; 22-23. *Moina micrura*; 24-25. *Alona davidi*; 26-27. *A. monacantha*; 28-29. *A. karua*; 30-31. *A. verrucosa*. 32-33. *Chydorus eurynotus*.

Guernella raphalis Richard, 1892

Size: 0.38 mm. Body slightly oval. Head concave ventrally, eye large, ocellus situated closer to apex of rostrum. Antennules short and broad with a group of sensory setae at apex. Valves with polygonal reticulations and serrated without setae. Postabdomen slightly bilobed with transverse rows of spinules and without anal denticles. Claw short without basal spines.

Not common, but occurs in decaying marshy regions of KNP. It has already been recorded by Venktaraman (1990).

Moina micrura Kurz, 1874 (Figs. 22-23)

Size: 0.73 mm. Head large, rounded with a deep cervical depression posteriorly. Eye large, ocellus absent. Antennules long and movable with a group of sensory setae on apex. Postabdomen with 6-8 ciliated lateral spines. Claw long, slightly curved dorsally, with pecten at base.

Very common. This is the most widely distributed species of *Moina*. It occurs both in ponds of Bharatpur and shallow regions of KNP.

Moinodaphnia macleayii (King, 1853)

Size: 0.81 mm. Head with distinct cervical depression. Eye large, ocellus small, situated closer to antennules than to eye. Antennules slender with long lateral seta and a group of sensory setae on the apex. Ventral margin of valve rounded with series of short marginal spines. Postabdomen without anal denticles, lateral surface with 8-10 ciliated spines. Claw long with a series of short setules along concave surface.

Not very common. Occurs only in the marshes of KNP. It has already been recorded by Venkataraman (1988).

Bosminopsis deitersi Richard, 1895

Size: 0.38 mm. Body oval. Head rounded, rostrum long with two lateral branches. Eye large. Valves with polygonal reticulations, dorsal margin with cervical depression, ventral margin with a long and pointed marginal spine on the postero-ventral corner. Postabdomen small with 4-6 groups of short spinules. Claw serrated with a large basal spine.

Not common. Occurs in open waters of Ajanbund reservoir, Bharatpur. It has already been recorded by Venkataraman (1988).

Alona davidi Richard, 1895 (Figs. 24-25)

Size: 0.35 mm. Maximum height slightly before middle. Postero-dorsal and postero-ventral corners rounded. Ventral margin projecting in the middle. Rostrum blunt. Antennules not reaching apex of rostrum. Ocellus smaller than eye, situated slightly nearer to the eye than apex of rostrum. Postabdomen with prominent preanal and postanal corners. Preanal corner projecting, anal margin with 8-10 groups of denticles. Claw with short basal spines.

Common. Occurs mainly in marshes with *Hydrilla* sp. in KNP and roadside ponds of Banbaretha, Bharatpur.

Alona monacantha Sars, 1901 (Figs. 26-27)

Size: 0.27 mm. Valves with longitudinal lines. Postero-dorsal and postero-ventral corners rounded, postero-ventral corner with 1-3 denticles. Ocellus smaller than eye. Antennules not reaching apex of rostrum. Labrum with small denticle on anterior margin. Postabdomen with distinct preanal corner. Lateral margin with 6-8 anal denticles followed by 3-4 groups of spines along the anal groove. Claw with long basal spines. Not common. Occurs mainly in marshes of KNP.

Alona karua King, 1853 (Figs. 28-29).

Size: 0.29 mm. Body with distinct lines and polygonal patterns. Postero-ventral corner rounded with 2-3 denticles followed by a row of setules. Antennules not reaching apex of rostrum. Ocellus small, situated closer to eye. Postabdomen broadly rounded. Claw with a short basal spine. Very common. Occurs in marshy habitats of KNP.

Alona verrucosa Sars, 1901 (Figs. 30-31).

Size: 0.28 mm. Body oval. Postero-ventral and postero-dorsal corners rounded. Antennules

almost reaching apex of rostrum. Ocellus small, situated slightly closer to eye than to apex of rostrum. Postabdomen with 5-6 denticles. Claw with short basal spine.

Common. Occurs in all marshy areas of KNP and in the Bharatpur ponds.

Camptocercus australis Sars, 1896

Size: 0.82 mm. Head smoothly curved. Postero-ventral margin slightly convex with 3-4 small denticles. Ocellus smaller than eye, situated closer to the eye than to the tip of rostrum. Labrum wedge-shaped and slightly rounded at apex. Postabdomen long with 16-18 anal denticles. Claws long, slightly curved dorsally and pointed.

Very rare. Occurs in Ghana canal of Keoladeo National Park. This is the first record of its occurrence in the Oriental region. However, the same species has been reported as a new species by Battish (1989) from Renuka lake. Only the comparison of type-specimens will give a clear picture about the validity of this species.

Chydorus eurynotus Sars, 1901 (Figs. 32-33)

Size: 0.24 mm. Body shape slightly oval. Postero-dorsal and postero-ventral corners distinct. Valves with faint reticulation. Rostrum slightly curved posteriorly. Ocellus smaller than eye, situated closer to eye than to apex of rostrum. Postabdomen with 10-12 short denticles. Claw with two basal denticles.

Common. Occurs in all marshy areas of Keoladeo National Park and in the Bharatpur ponds.

Chydorus parvus Daday, 1898 (Figs. 34-35)

Size: 0.28 mm. Body rounded. Postero-dorsal corner distinct, postero-ventral corner rounded without denticle. Ventral margin with 2-3 chitinous tubercles. Surface of carapace without reticulation. Ocellus smaller than eye and situated closer to eye than to tip of rostrum. Postabdomen with distinct preanal corner. Dorsal margin with 6-8 anal denticles. Claw with two basal spines.

Not common. Occurs in marshy regions of KNP and in the ponds of Bharatpur.

Chydorus ventricosus Daday, 1898 (Figs. 36-37).

Size: 0.76 mm. Body oval. Postero-ventral corner rounded, without denticle. Valves with hexagonal markings. Rostrum long and pointed. Labrum long, curved anteriorly and slightly pointed. Postabdomen long with distinct preanal corner. Dorsal margin with 9-10 anal denticles. Claw setulated along concave surface with two basal spines.

Not common. Occurs in marshes of KNP and in the ponds of Bharatpur.

Dadaya macrops (Daday, 1898) (Figs. 38-39).

Size: 0.48 mm. Body oval with polygonal reticulations. Postero-ventral corner with a distinct denticle. Rostrum short, antennules long. Ocellus and eye large, ocellus situated slightly closer to eye than to apex of rostrum. Postabdomen with 10 groups of irregular sized denticles. Claw with setules on concave surface and a long basal spine.

Common. Occurs in marshes of Keoladeo National Park and roadside ponds of Banbaretha, Bharatpur.

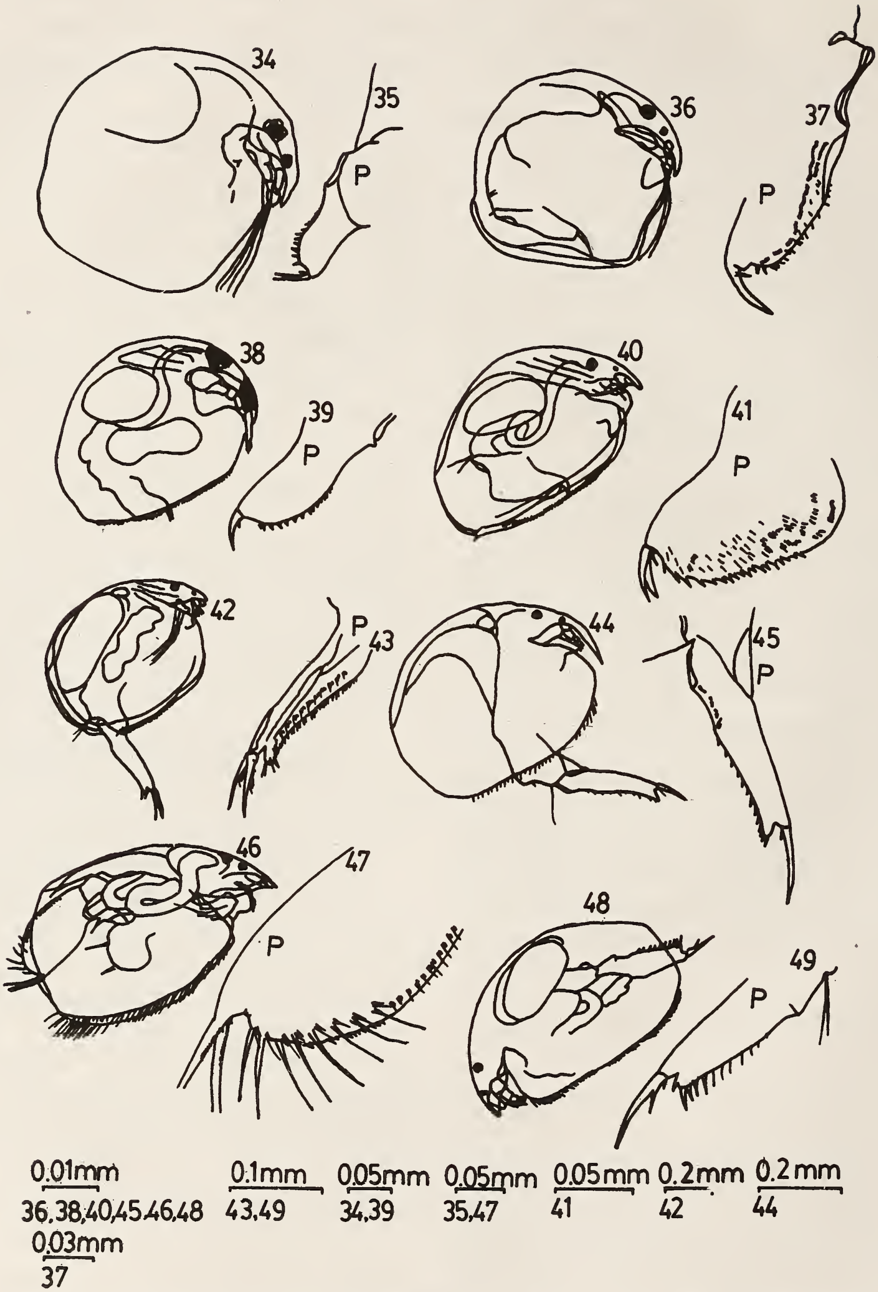
Dunhevedia crassa King, 1853 (Figs. 40-41)

Size: 0.53 mm. Body curved dorsally. Postero-ventral corner of valves with a bifurcated denticle. Rostrum blunt, labrum rounded with pointed apex. Ocellus small and situated slightly closer to eye than to apex of rostrum. Postabdomen with groups of scattered spinules, claw setulated with one basal spine.

Not common. Occurs in marshes of Keoladeo National Park and in the Ajan bund reservoir.

Euryalona orientalis (Daday, 1898). (Figs. 42-43)

Size: 0.99 mm. Valves with rectangular reticulations. Postero-ventral margin of valves with series of setae. Rostrum blunt, antennules almost reaching apex of rostrum. Labrum rounded with a nipple-like structure on apex. Postabdomen long with 20 pointed denticles decreas-



Figs. 34-49. Cladocera of Keoladeo National Park and its environs (females). P–postabdomen. 34-35. *Chydorus parvus*; 36-37. *Chydorus ventricosus*; 38-39. *Dadaya macrops*; 40-41. *Dunhevedia crassa*; 42-43. *Euryalona orientalis*; 44-45. *Kurzia longirostris*; 46-47. *Leydigia acanthocercoides*, 48-49. *Oxyurella sinhalensis*.

ing in size proximally. Claw long with a very short basal spine. Common among weeds in KNP.

Kurzia longirostris (Daday, 1898) (Figs. 44-45)

Size: 0.45 mm. Valves without longitudinal lines. Rostrum long, antennules short, reaching half of the rostrum. Ocellus smaller than eye, situated nearer to the eye than to the apex of rostrum. Labrum with slightly pointed apex. Postabdomen long with 12 groups of denticles present dorsally; lateral side with 11-12 groups of short setules. Claw long with a short basal spine. Rare. Occurs among the weeds in KNP.

Leydigia acanthocercoides (Fischer, 1854) (Figs. 46-47)

Size: 0.89 mm. Valves with longitudinal lines. Rostrum blunt, antennules not reaching apex of rostrum. Ocellus smaller than eye, situated closer to the eye than to the apex of rostrum. Labrum rounded with fine setae. Postabdomen with about 18 groups of small denticles, each group consists of 3 or 4 denticles with the distal-most denticle being the longest of each group. Claw with a short basal spine.

Rare, occurs in reddish-brown algal covered ponds of Bharatpur.

Indialona globulosa (Daday, 1898)

Size: 0.36 mm. Valves with striations. Rostrum short and blunt, antennules not reaching the apex. Ocellus smaller than the eye, situated closer to the eye than to the apex of rostrum. Labrum serrated on antero-ventral margin. Postabdomen long with 12 or 13 anal denticles, claw long with 12 or 13 anal denticles, claw long with short basal spine.

Rare. Occurs in small numbers in marshes of KNP and Banbaretha ponds.

Oxyurella sinhalensis (Daday, 1898) (Figs. 48-49)

Size: 0.82 mm. Valves evenly rounded. Rostrum blunt, antennules not reaching the apex. Ocellus smaller than the eye and situated closer to the eye than to the apex of rostrum. Labrum round. Postabdomen long with 10-12 anal denticles which decrease in size proximally. Claw long with a long basal spine and three short spines proximal to the basal spine. Not common. Occurs in the marshes of KNP.

Discussion

The cladoceran fauna of Keoladeo National Park has some features unique to this region. A total of 39 species of Cladocera belonging to six families is recorded in the present study, of which 25 are recorded for the first time from Rajasthan. An analysis of the published records shows that in a tropical region around 60 species have been normally recorded, while a temperate region supported around 95 species of Cladocera (Fernando 1980). The six species of limnetic Cladocera are limited in this region compared to temperate regions. As an example, in Ontario at Canada, Brandlova *et al.* (1972) recorded 18 species of limnetic Cladocera.

Similar figures can be quoted for all the northern temperate regions (Flossner 1972, Manuilova 1964, Scourfield and Harding 1966). In the southern temperate zone, Hebert (1977) found 10 limnetic species of *Daphnia* in south-eastern Australia. On the other hand, the number of species in Sri Lanka (Fernando 1980), south India (Venkataraman 1983) as well as other tropical areas of south-east Asia (Fernando 1980) is less than that of temperate regions. However, in Keoladeo National Park lying within the temperate zone, only three species of *Daphnia*, namely *D. similis, D. lumholtzi* and *D. longispina*, occurred.

Venkataraman (1983) recorded and commented upon six species of non-Indian cladoceran species in south India. Ghetti (1970) also recorded one non-European ostracod species in Italy. More recently Fernando (1980) recorded two unexpected species from Sri Lanka. Mukhamediev (1951) considered seed (agricultural) as a means of transporting tropical fauna and flora into subtropical regions of the USSR.

There is thus enough evidence to show the presence of temperate Cladocera in tropical India (Venkataraman 1983) and Sri Lanka (Fernando

1980). The present study also reveals the cladoceran species *Daphnia similis, Diaphanosoma senegalensis, Camptocercus australis, Leydigia australis* and *Pluroxus similis* as introduced ones. Birds have been considered an important agency for the dissemination of microcrustaceans in freshwaters (Thienemann 1950, Loffler 1963, Smirnov 1974). Keoladeo National Park attracts several aquatic bird migrants (Ali and Vijayan 1983). Perhaps bird sanctuaries, besides attracting aquatic migratory birds, also provide congenial conditions for the alien fauna and flora to colonise these aquatic ecosystems.

Acknowledgements

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FOOD AND FEEDING BEHAVIOUR OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS)[1]

BHARAT BHUSHAN[2] AND ASAD R. RAHMANI[3]

(With two plates and four text-figures)

INTRODUCTION

The great Indian bustard *Ardeotis nigriceps*, endemic to parts of the Indian subcontinent, is an endangered avian species. It is included in Schedule I of the Wildlife (Protection) Act, 1972, and a number of sanctuaries have been established for its protection (Rahmani 1987, 1989). The present study on the food and feeding behaviour of the species forms part of a wider investigation on its ecology. Studies on food and feeding behaviour were mainly done at Karera Bustard Sanctuary, Madhya Pradesh, but wherever necessary, data from other sites such as Nanaj bustard area in Solapur district, Maharashtra, and Rollapadu Bustard Sanctuary in Kurnool district, Andhra Pradesh, are also included.

Owing to its status as a game bird, the natural history of the great Indian bustard, including its food, has been described by many workers; but there is no detailed study on its feeding behaviour and seasonal dependence on different food items. This paper deals with these aspects. The study is based largely on faecal analysis. While previous reviews of food habits analyses (Hartley 1948, Van Tyne and Berger 1959, Korschgen 1969, Lorin 1970) maintain that analysis of faecal matter should be the last alternative for study, they also accept that it is the only solution where endangered species are concerned.

STUDY AREA

The 202.21 sq. km Karera Bustard Sanctuary (25°30' to 24°40'N, 78°5' to 78°12' E) (henceforth Karera) is located in Shivpuri district, Madhya Pradesh. The average annual rainfall recorded by us from 1983 to 1985 was 966 mm. Summers (March to June) are very hot (maximum recorded 48°C), but temperatures as low as 4° C have been recorded in winter (November to February). The terrain is gently undulating, with scattered stones and boulders.

The original vegetation of the area was classified as Tropical Dry Deciduous Forest (Champion and Seth 1968). There are a few hillocks, which some decades ago would have been covered with *Anogeissus pendula* trees, but indiscriminate cutting and lopping have eroded the hills, leaving stunted specimens. The plains have degraded into open scrub. Wherever possible, the land has been cultivated. Today the shrubs *Zizyphus rotundifolia* and *Acacia leucophloea* are the dominant natural plants, the latter scattered and the former in clumps in all the uncultivated parts of the plains.

In the scrub area, along with *Zizyphus*, various grasses were found but severely exploited by livestock. Except for private fields, the entire area was totally grazed. Among grasses *Heteropogon contortus, Cynodon dactylon, Andropogon pumilus, Pennisetum pedicellatum, Aristida* spp. and *Eragrostris* spp. were common.

A number of ephemeral streams run across the sanctuary and flow into the village tanks or rivers. These streams dry up by the end of September or October. With constant soil erosion in the hills, the dried stream beds show presence of soil, gravel and rocks all along their course.

There are 33 villages within the boundary of the Sanctuary, and both human density (127 persons/sq. km) and the livestock population (179.5/sq. km) are high.

The bustards are found in open scrubland. During our study period, there were about 25 bustards in the Sanctuary. The breeding season at

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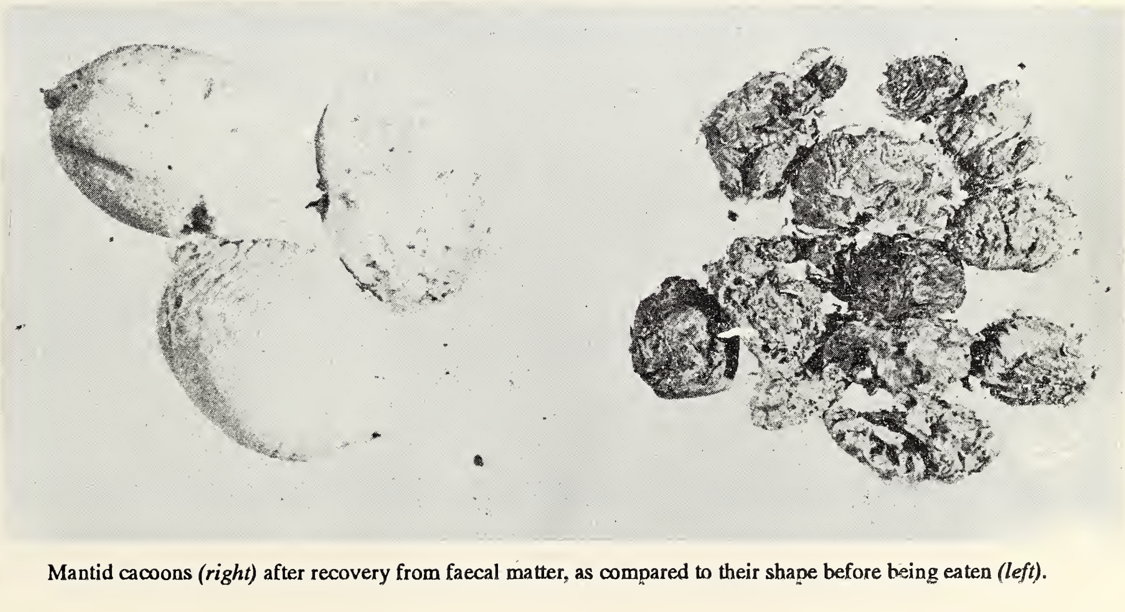
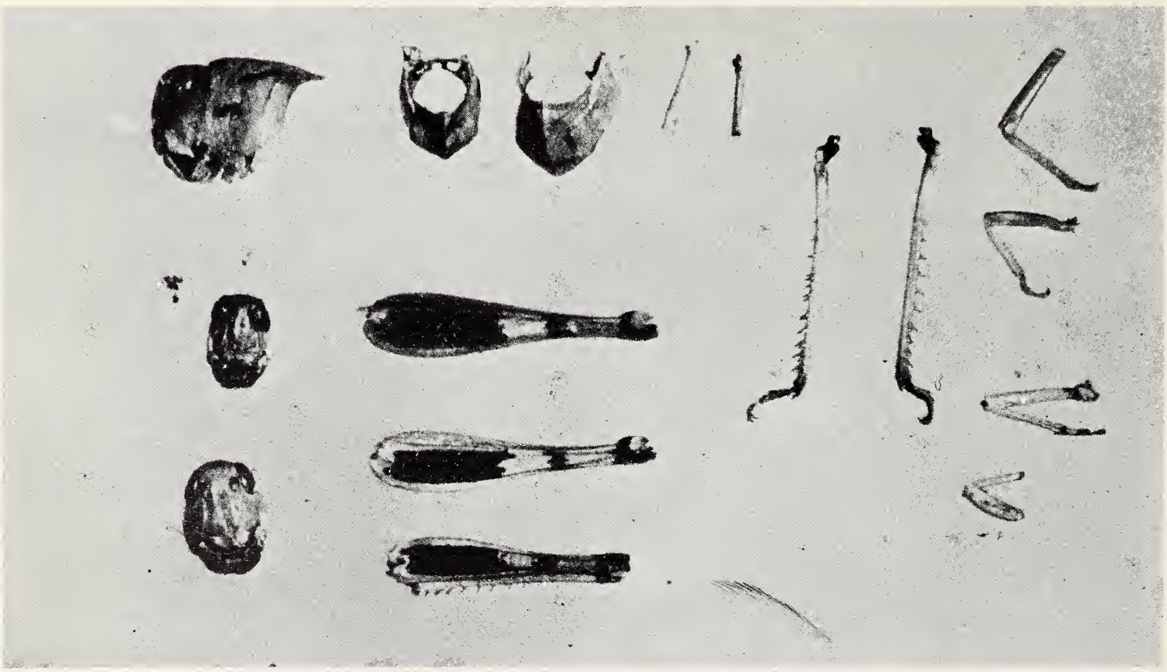
Fig. 1. Study area in the Great Indian Bustard Sanctuary, Karera.

Chana *Cicer arietinum* plant matter recovered from bustard faeces. *Left:* whole shredded and fibrous pod material. *Right above:* whole seeds. *Right below:* shredded and fibrous stalk material.



Mantid cacoons *(right)* after recovery from faecal matter, as compared to their shape before being eaten *(left)*.

Coleopteran body parts recovered from faecal matter.



Orthopteran body parts recovered from faecal matter.

Karera is from mid March to end June. Although occasional nests were found in July and August as well, courtship display of adult males was not seen after June.

The other areas were Nanaj (for details see Ali and Rahmani 1982-84, Rahmani and Manakadan 1989) and Rollapadu (see Manakadan and Rahmani 1989).

Methods

Study plots: Seven plots where bustards were seen foraging were selected (Fig. 1). The names of these plots are based on local names. Detailed descriptions of the plots are given by Bhushan (1985) and Rahmani (1989).

Analysis of faecal samples: More than 300 faecal samples were collected at Karera for analysis to determine the bustard's varying dependence on seasonal food. Most of the samples were collected from roosting sites. Wet samples were preserved in 10% formalin, and dry samples preserved in separate packets for later analysis. Analysis was done on the basis of Korschgen (1969) and Lorin (1970). Faecal material was studied under a stereoscopic binocular microscope. Various items in the diet were identified by comparison with reference material or directly in the case of such undigested parts as chelicera (arachnida) , elytra and mandible (insects), seed (*Triticum, Zizyphus*) and pod (*Cicer, Arachis*).

Figs. 2 and 3 show the percentage weight of various food items in the faecal material collected fortnightly. Although insects appear to be preferred by the bustards (visual observations), they are under-represented in the figures, mainly because they were digested and thus did not show relative proportions in the faecal material. On the other hand, plant material is over-represented mainly because many plant parts (i.e. seed) remain undigested and are thus easily identified and weighed. Small reptiles which are opportunistically eaten (visual observations) were not recorded in the faecal material. These limitations should be kept in mind while interpreting figures.

Feeding rates: The bustards were observed while foraging by the scanning method, wherein the bird was watched continuously for a five minute unit, termed here as a 'scan'. During a single scan, each peck by the bustard away from its lateral position was counted. The total number of pecks in a single scan was considered to be the feeding rate (or peck rate) for that particular scan (after McKee 1982). The scan count was discontinued when the bird went out of view.

Peck rates were studied from May 1982 to August 1984 and 1271 readings were taken, spread over different seasons and months. For various reasons, equal number of readings could not be taken every month or every season. Most readings were taken during the breeding season (summer) and in winter, when the birds were watched more regularly.

Identification: To study the peck rate of different individuals, bustards were identified as (i) Alpha male = adult territorial male; (ii) Beta male = subadult non-territorial male; (iii) Juvenile male = less than one year old, generally seen with the mother; (iv) Mother = hen with juvenile; (v) Breeding female = hen with an egg or a chick; and (vi) Non-breeding female = hen without an egg or chick.

Entomological studies: Sweeping method was used to count the insect number. Weekly sweeps were carried out in different plots. 100 sweeps each were done over a fixed stretch of an area in each plot, between 0700 and 0900 hrs. The main emphasis was on the study of grasshoppers, which constitute the major animal food of the bustard, and are comparatively large and easy to identify and count. Moreover, sweeping method is much more effective to study the population of Orthoptera and Lepidoptera than Coleoptera. The insects caught or flushed during sweeping were counted.

The following were the common Orthopterans and Lepidopterans found in the study area: *Acrida exaltata, Chloeobora* sp., *Chrotogonus* spp., *Dnopherula* sp., *Gastrimargus africanus, Locusta migratoria, Pyrgomorpha* sp., *Spathosternum* sp., *Acorypha* spp., *Catantops* sp., *Chorthippus* sp., *Eyprepoenemis* sp., *Hieroglyphus* sp., *Patanga* sp., *Poicilorhynchus*

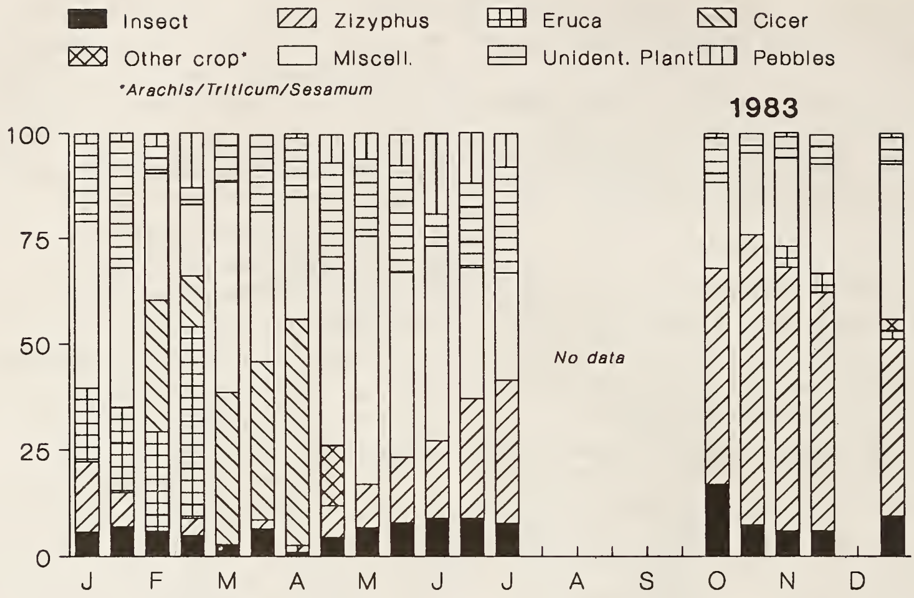


Fig. 2. Percentage of various food items in faecal samples of great Indian bustard collected in 1983.

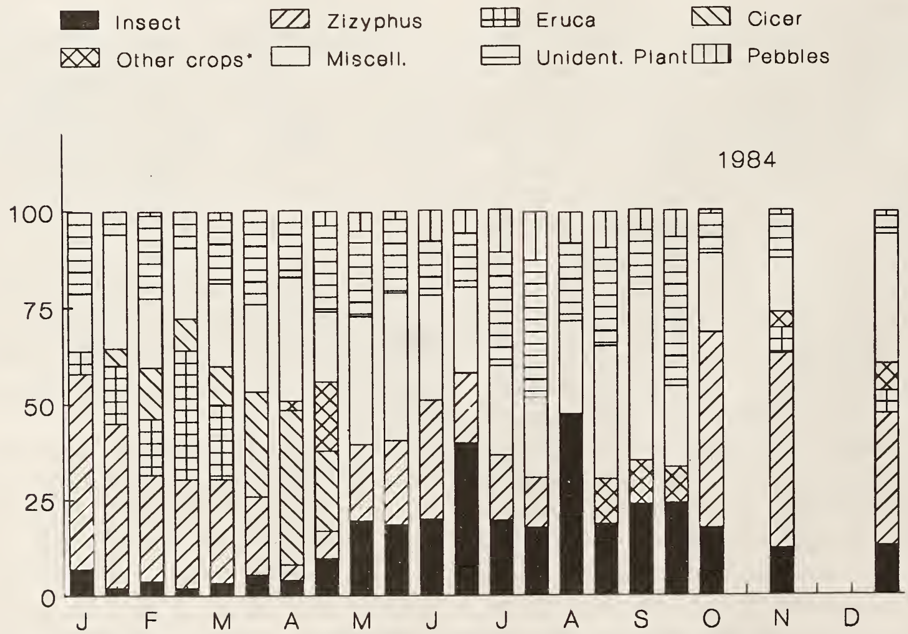


Fig. 3. Percentage of various food items in faecal samples of great Indian bustard collected in 1984.

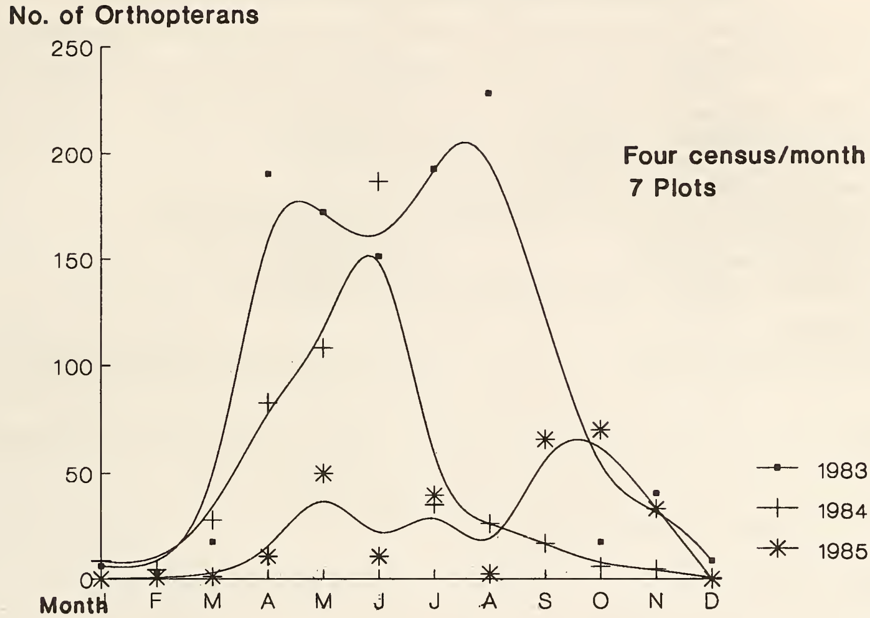


Fig. 4. Monthwise and inter-annual variation in numbers of Orthoptera in the study area.

pictus and *Sphingonotus* sp.; and *Tarucus indica*, *T. nara*, *T. theophrastus*, *Eurema brigitta*, *Precis lemonias*, *Precis orithyia*, *Papilio demoleus*, *Acraea violae*, *Hypolimnas misippus* and *Belenois mesentina*.

Though Coleopterans are commonly eaten by bustards (Ali and Ripley 1969, Bhushan 1985), they are mainly crepuscular or nocturnal, and are rarely caught in the sweep net. Pitfall traps (using petri-dishes filled with formalin to trap beetles) were not used in order to avoid accidental drinking of formalin by bustards and wild mammals. Moreover, there were always chances of petri-dishes being broken by grazing livestock or by blackbuck.

Five habitat types were selected for insect studies: (i) Open scrub; dominated by *Zizyphus rotundifolia* (average height 50 cm) and very low tree density (<1 tree/10 ha). (ii) Usar area; bare, alkaline area, dominated by *Chloris stricta* grass. (iii) Wooded scrub: dominated by *Z. rotundifolia* and *Acacia leucophloea* (tree density > 5/10 ha). (iv) Inside plantation; totally protected 20 ha forest plantation, dominated by various grasses (height >100 cm) and some trees (density >1 tree/10 ha). (v) Outside plantation: very similar to Open scrub, i.e. dominated by *Zizyphus rotundifolia*; this category was selected to compare the counts with the adjoining Plantation plot.

Results

Population fluctuation of Orthoptera and Lepidoptera: At Karera, the orthopteran population was very low during winter (October to February). From the middle of March, it starts rising and reaches its peak during the late summer or monsoon. Inter-annual variation was seen in population as well as in the timing of peaks and troughs (Fig. 4). These were also dependent on local factors such as precipitation and temperature.

The lepidopteran number, on the other hand, is generally low in late winter and summer, but soon after the monsoon breaks, it starts increasing and reaches its peak during August and September.

TABLE 1
LITERATURE REVIEW OF THE FOOD OF THE GREAT INDIAN BUSTARD

Food recorded	References
Insects	
"Grasshoppers, *Mylabris, Buprestris,* Scarabaei..."	Hume and Marshall 1879
"Grylli, beetles of all kinds (Cetonidae, Elateridae, Buprestidae, Carabidae), frequently the spongy nidus of the mantis, caterpillars, Julidae, Scolopendridae...."	Elliot 1880
"Locusts, grasshoppers, beetles, crickets, mole-crickets, ants"	Dharmakumarsinhji 1957
Green blister beetle *Cantharis tenuicollis*	Ali and Ripley 1969
Beetles (*Gymnopleurus?, Atactogaster*)	Gupta 1975
Curculionidae: *Platynotus, Mylabris, Sternocera nitidicollis*	Manakadan 1985
Scorpions, spiders etc.	
"Centipedes, spiders, scorpions, worms"	Hume and Marshall 1879, Elliot 1880, Dharmakumarsinhji 1957, Gupta 1975
Reptiles	
"Lizards, snakes..."	Hume and Marshall 1879, Dharmakumarsinhji 1957, Ali and Ripley 1969
Echis carinatus	Carter 1912
Uromastix hardwickii	Gupta 1975
Bird eggs	
Egg of *Coturnix*	Hume and Marshall 1879
Mammals	
Rats	Hume and Marshall 1879
Mice	Dharmakumarsinhji 1957
Plants*	
"green shoots of lemon grass *Citronella*"	Dharmakumarsinhji 1957
Carissa	Hume and Marshall 1879, Gupta 1975
Salvadora	Dharmakumarsinhji 1957
Inanimate matter	
"stones & gravel", "pebbles"	Hume and Marshall 1879, Elliot 1880, Dharmakumarsinhji 1957
"brass ornament"	Hume and Marshall 1879

*Plants included here are not listed in Table 2.

FOOD RECORDED THROUGH FAECAL ANALYSIS
SEASONAL VARIATION

Winter (October to February): Winter in Karera starts in October. Insect numbers start declining, and the monsoon crop such as groundnut *Arachis hypogea*, as well as *Zizyphus* drupes, start ripening. In the beginning of October, bustards were mainly seen feeding on insects and drupes of *Zizyphus*. By mid-October, the insect number declines rapidly and bustards feed more and more on the ripe drupes of *Zizyphus*. While insects constituted 13% of the diet (by weight) in the first fortnight of October 1983, in the second fortnight they declined to 7% (Fig. 2). On the other hand, the percentage of *Zizyphus* increased from 65 to 68%.

In November also, drupes of *Zizyphus* constitute the major food (Fig. 2). Soeha *Eruca sativa*, which is a dryland winter crop at Karera, is relished by bustards. So is groundnut; bustards are frequently seen in groundnut fields, foraging on exposed nuts. They do not dig up the plants. However, we did not obtain groundnut in faecal samples.

TABLE 2
PLANT SPECIES IDENTIFIED IN THE BUSTARD DIET

Family	Species	Remarks
CRUCIFERAE	*Eruca sativa*	Crop
	Brassica campestris	Crop
MALVACEAE	*Hibiscus abelmoschus*	Wild plant/weed
TILIACEAE	*Triumfetta rhomboides*	Wild plant
LINACEAE	*Linum usitatissimum*	Crop
RHAMNACEAE	*Zizyphus rotundifolia*	Wild plant
LEGUMINOSAE	*Cicer arietinum*	Crop
	Arachis hypogea	Crop
	Vigna sinensis	Crop
CUCURBITACEAE	*Cucumis melo*	Wild plant/weed
PEDALIACEAE	*Sesamum indicum*	Crop
GRAMINEAE	*Sorghum vulgare*	Crop
	Triticum vulgare	Crop

In December, the percentage of *Zizyphus* in the diet of bustards declined to less than 50% (Fig. 2), while the percentage of *Eruca sativa* did not change significantly. Similarly, there was not much change in the insect constituents. Vegetal matter remained the major part of the diet as indicated by the faecal samples.

Although *Zizyphus* drupes are more or less exhausted by January, bustards were still able to pick up sufficient numbers to constitute up to 51% by weight in the first fortnight of 1984 (Fig. 3). In both 1983 and 1984, in the second fortnight of January the percentage of *Eruca sativa* increased (Figs. 2, 3).

This is further corroborated by our visual observations in the field. The insect number was very low (Fig. 4) and hence bustards were more frequently seen in the crop fields of soeha and Bengal gram *Cicer arietinum*. Sometimes complete pods of gram were found in the droppings but we rarely saw them eating the pods of soeha. Occasionally, they were seen feeding on mustard *Brassica campestris* and til *Sesamum indicum*.

In the first fortnight of February, *Eruca sativa* constituted 14.7 and 23.4% in 1983 and 1984 respectively, while in the second fortnight it increased to 33.6 and 45.7% (Figs. 2, 3). Similarly, the percentage of Bengal gram also increased in the second fortnight. In 1983, we found very little *Zizyphus* in the faecal samples, unlike 1984 when in both the fortnights, *Zizyphus* constituted 28% (Fig. 3). This could be due to a sampling error. In 1983 only five samples were analysed in each fortnight while in 1984, 12 and 16 samples were studied, which showed the diet variation more clearly. In February, as in other winter months, insects formed less than 10% of the diet of the bustard (as shown by faecal sample analysis).

Summer (March to June): In early March, the Bengal gram and soeha start ripening but the bustards are still seen in the crop fields, picking up the late flowers of soeha and unripe pods of Bengal gram. Insects start increasing in number (Fig. 4) but still formed less than 10% in the faecal samples analysed by us (Figs. 2, 3).

By the third week of March, when harvesting of early-grown wheat begins, bustards can be seen in newly harvested wheat fields, picking up the fallen grains. Soeha is also harvested by the fourth week of March, after which bustards are rarely seen in soeha fields. Breeding of bustards at Karera starts from the middle of March (Rahmani 1989). During the first fortnight of April Bengal gram is the main standing crop eaten by bustards at Karera, and constituted nearly 50% of the diet. Its percentage declined during the second fortnight (Figs. 2, 3). At the same time the percentage of wheat increased in faecal samples as more fields are harvested. By the third week of April all wheat fields are harvested and livestock grazed on crop residue.

With the approach of summer and rise in temperature, small reptiles come out of hibernation and the population of *Sitana ponticeriana*, *Agama minor*, *Mabuya* spp., *Ophisops jerdonii* and *Calotes versicolor* increases. *Sitana*, *Ophisops* and *Agama* are easily caught by foraging bustards because these small lizards generally depend on camouflage, remaining immobile when danger threatens. We often saw bustards with small lizards, but rarely saw them catching *Calotes versicolor* which is mainly arboreal. An injured *Calotes* offered to our captive-cum-free ranging juvenile bustard at Rollapadu was not eaten by it (Manakadan and Rahmani 1990). However, we suspect that an adult bustard can easily eat a *Calotes* because we have seen them eating snakes, sometimes larger than an adult *Calotes*.

During May and June there is hardly any crop at Karera and bustards depend totally on natural food (Figs. 2, 3). Insects, especially Orthopterans, reach maximum numbers, and form the main food, though this is not reflected in faecal analysis for reasons stated earlier (Fig. 4).

Monsoon (July to September): With the onset of the monsoon in end June or early July, agricultural activities begin and millet, pennisetum, sesamum and groundnut are grown. Insect numbers remain high and constitute nearly 10% of the diet of the bustard (as indicated by faecal samples, though it must be higher) (Fig. 2). In August 1984 (we have no data for August 1983), insects constituted 47.31% in the first fortnight and 18.52% in the second fortnight (Fig. 3).

Bustards also feed on *Cucumis melo* var. *momordicum*. Locally known as 'gila', the cucumber-like *Cucumis melo* is locally considered as a weed and grows naturally in groundnut fields. Bustards feed on the fruit (3-5 cm long and 2-3 cm broad), and presumably digest the entire fleshy matter and possibly the unripe seeds also, because only the hard seeds were found in faecal samples.

During September, insects constituted about 20% of the diet (Fig. 3). Groundnut is a new crop which is added to the food of the bustard from this month onward till it is harvested in November/early December. Bustards are first seen in the groundnut fields when it is sown, and later when it is ready for harvesting. As the groundnut plant is very short (20-30 cm), it is suitable for bustards and the birds are regularly seen there.

By the end of September, monsoon crops are harvested and fields are prepared for winter crops such as wheat, soeha and Bengal gram. The insect numbers start declining. At the same time, drupes of *Zizyphus* start ripening and more bustards are seen picking the drupes from bushes. The cycle repeats itself.

Crop Plants Eaten by Bustards

Soeha: Soeha or taramira is a dry-land winter crop extensively grown in Karera and the whole of north-west India. We have seen it grown in Sorsan, Sonkhaliya (Rajasthan), Ghatigaon and Pohri (Madhya Pradesh) bustard areas/ sanctuaries. The whole plant – inflorescence, leaves and shoots – is eaten by bustards. As long as there are flowers and fresh green leaves, bustards are seen in soeha fields. Some of the highest peck rates were found in the soeha fields (see Table 3).

Soeha is a marginal crop, grown only in those areas where irrigation facilities are scanty. If a field can be irrigated, farmers prefer to grow more commercially profitable crops.

Bengal gram: After soeha, Bengal gram *Cicer arietinum* is the most preferred crop of bustards at Karera. Cool dry climate and light well-drained soil are essential for successful cultivation. It can be grown with or without irrigation. The plant is 30-40 cm tall and is grown in narrow rows. At Karera, it is mainly grown in non-irrigated or marginally irrigated areas. Sometimes it is grown with wheat.

Bustards eat young shoots, flowers and unripe pods of Bengal gram. The highest peck rates were observed in Bengal gram fields (Table 3). If undisturbed, they visit the same gram fields over consecutive days. We have recorded stems, leaves, seeds and pods in the faecal samples.

Occasionally, an entire pod with seeds within was recovered in the droppings.

Groundnut: This is one of the most important commercial crops of Karera and in almost all the bustard areas (except the Thar desert). It is grown mainly as a monsoonal crop, sown at the start of the monsoon and harvested in October/November. As groundnut is favoured by bustards, their presence can be predicted in a particular field. Soon after the water has dried from a freshly irrigated groundnut field, bustards visit the field to pick up nuts that have been exposed by the flow of water. Similarly, they are seen for many days in a newly harvested field where some nuts are left behind. The birds move from one harvested field to another, consuming the scattered nuts. We were able to bait bustards during summer by spreading wheat and groundnuts in areas frequented by bustards. An interesting behaviour seen from the hide was that the bustards shake the nuts before eating; spoiled nuts, which possibly do not produce the characteristic rattling sound, were discarded.

Wheat: We never saw any bustard eating wheat *Triticum vulgare* from the spike in a standing wheat field. They were mainly seen as soon as the wheat was harvested, picking up the fallen grains. On a few occasions we also saw them picking up fallen grains from cart-tracks after wheat-laden carts had passed by. Wheat was another food item by which we were able to attract bustards at Karera.

Incidentally, bustards at Nanaj were not attracted to wheat when we tried to catch them for colour banding. Similarly, at Karera, we were unable to attract bustards to wheat bait after the onset of the monsoon. This could be due to two major reasons: (i) during monsoon bustards get sufficient food in their natural habitat, and so are not particularly attracted to wheat, and (ii) damp soil quickly spoils the grain which bustards do not eat.

Millet: Unlike wheat, bustards were found to eat millet (jowar) *Sorghum vulgare* from the standing crop plants. At Nanaj, many bustard droppings had millet seeds, and on a few occasions we saw bustards pecking at spikes of millet.

Mustard: Although closely related to soeha, mustard *Brassica campestris* is not a preferred food of the bustard. Only once was a male found eating green leaves from standing plants. It is commonly grown at Karera, Pohri, Ghatigaon, Sonkhaliya and the whole of north-west India, either alone or with wheat or sesame.

Cowpea: Twice we saw a male bustard eating the beans of cowpea *Vigna sinensis*. However, cowpea was never found in faecal samples.

Linseed *Linum usitatissimum:* This crop is commonly grown along with soeha and Bengal gram. Although we did not see the bustard feeding on this plant, seeds were recorded in the faeces..

Peck Rate

Feeding or peck rate (PR) per five minutes was analysed with a combination of various other parameters.

Sex-wise peck rate: The average peck rates (PR) of male and female bustards in the Open scrub area were significantly different (One-way ANOVA, $F_{1,1019} = 4.33$, $P < 0.05$). Males had a higher PR than females.

Habitat-wise peck rate: (Table 3) The maximum number of observations were taken in the Open scrub area (n = 1028, 80%). More than 80% of the natural area of the Sanctuary consists of *Zizyphus rotundifolia*-dominated scrubland.

Fallow fields are quickly invaded by *Zizyphus* and within two or three years become almost like the Open scrub area. In both Open scrub area and fallow fields, livestock grazing is allowed.

Expectedly, there was not much difference in the PR between these two similar habitats (Table 3). Some fallow fields in which livestock grazing is not allowed, become dominated by grasses. We have considered them as grassland. The PR was slightly higher in Grassland than in Open scrub area or fallow fields (Table 3). This could be due to the higher number of insects in the grassland. Unfortunately, our sample size is very small (only 12 observations). This was mainly because

TABLE 3
AVERAGE PECK RATES OF BUSTARDS IN DIFFERENT HABITATS

Habitat	Mean	SD	No. of samples
Chana (Bengal gram)	67.40	37.29	40
Soeha	46.48	28.00	93
Miscellaneous crops	41.22	36.36	28
Groundnut	15.33	3.77	6*
Grassland	13.91	4.75	12*
Open Scrub	12.09	10.23	1028
Fallow field	10.87	4.34	56
Usar area	3.87	2.89	8*

*Sample too small for statistical analysis n = 1271.

grassland patches in Karera are small and temporary. As soon as the grass becomes tall, it is either cut for hay or grazed.

The Usar is more or less totally bare ground with negligible ground cover. In the Usar, the peck rate was also very low (3.87, n = 8). The Usar was rarely used for foraging, hence the low sample size. We saw bustards in the Usar when they were crossing from one Open scrub area to another.

Among the crop fields, Bengal gram had the highest peck rate (Table 3). This is probably because the plants are only about 30 cm high, and when ripe, the green pods are easily picked by bustards. As the plant is grown closely in narrow rows, the bird does not have to move much and from one or two spots, it can pick up a large number of pods. Moreover, we have also seen bustards plucking the green leaves of chana (which does not require much effort); hence the very high PR in chana fields.

We recorded bustards in chana fields in October and December, though faecal analyses do not show presence of chana in these fortnights. The bustards must have fed on tender shoots that were easily digested or were not identifiable in faecal analysis.

The second highest peck counts, after chana fields, were seen in the soeha field (Table 3). Here too, the bustard does not have to move much or search for food once it is in a soeha field. We have often seen bustards eating the whole plant, starting from inflorescence, leaves, tender branches to the green part of the stem.

In groundnut fields, the bustard has to search for exposed pods. This could explain the PR of 15, compared to 46 and 67 in other crop fields (Table 3). Another explanation could be that groundnut pods being much bigger (and perhaps more nutritious) than chana pods and leaves and flowers of soeha, the bustard has to peck less to get the same amount of food.

Plot-wise peck rate: The plot-wise PR is shown in Table 4. In order to study the availability of natural food in different parts of the Sanctuary, we analysed the PR in the Open scrub areas of different plots (Table 4) and found no significant difference (One-way ANOVA, $F_{6,975} = 0.017$, NS).

Peck rates of different individuals: There was no significant difference in the PR of Alpha and Beta males or Alpha and Juvenile males (Tables 5, 6). Similarly, there was no significant difference between Mother and Juvenile which foraged together in the same areas. The only significant difference in the PR was between Breeding hens and other individuals such as Non-Breeding hens, Mother, Alpha and Beta.

Peck rates of solitary and non-solitary birds: We compared the PR of the solitary and non-solitary bustards in the Open scrub areas (Table 7), where the bustards spent most of their time. There was no difference in PR between solitary and non-solitary hens ($t = -0.29$, St. Err. = 2.11, Df = 437, NS) and very little difference between solitary and non-solitary males ($t = -1.76$, St. Err. = 0.67, Df = 587, $P < 0.1$). This shows

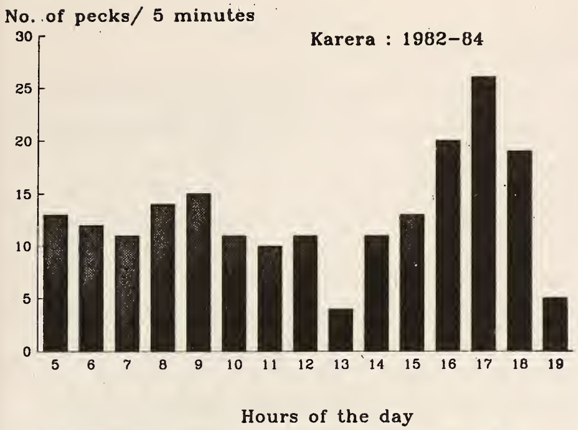


Fig. 5. Feeding intensity in the great Indian bustard at Karera.

that even when the bustard is in a flock, it feeds more or less individually.

Peck rates at different hours: Peck rates were higher in the late morning, and in the evening before roosting (Fig. 5). This could be because before roosting the birds have to eat sufficient food, so they peck faster before conditions become difficult for foraging. Maximum peck rates were observed in the evening. An additional reason for the high peck rate in the late evening could be that in the evening most of the villagers and livestock would return to villages; therefore bustards are left relatively undisturbed to forage, and could devote more time to eating (pecking). Expectedly, the peck rates drop suddenly after 1800 hrs because the birds are not able to locate their prey easily after dusk. At this time, most of the bustards roam in search of roosting spots and eat desultorily. With the approach of nightfall, risk of predation increases, so the birds spend more time looking for danger and less on foraging.

Minimum peck rates were seen during mid-day (Fig. 5), especially during summer when the temperature can reach 48° C. Mid-day foraging was seen more frequently in winter or during cloudy days in the monsoon.

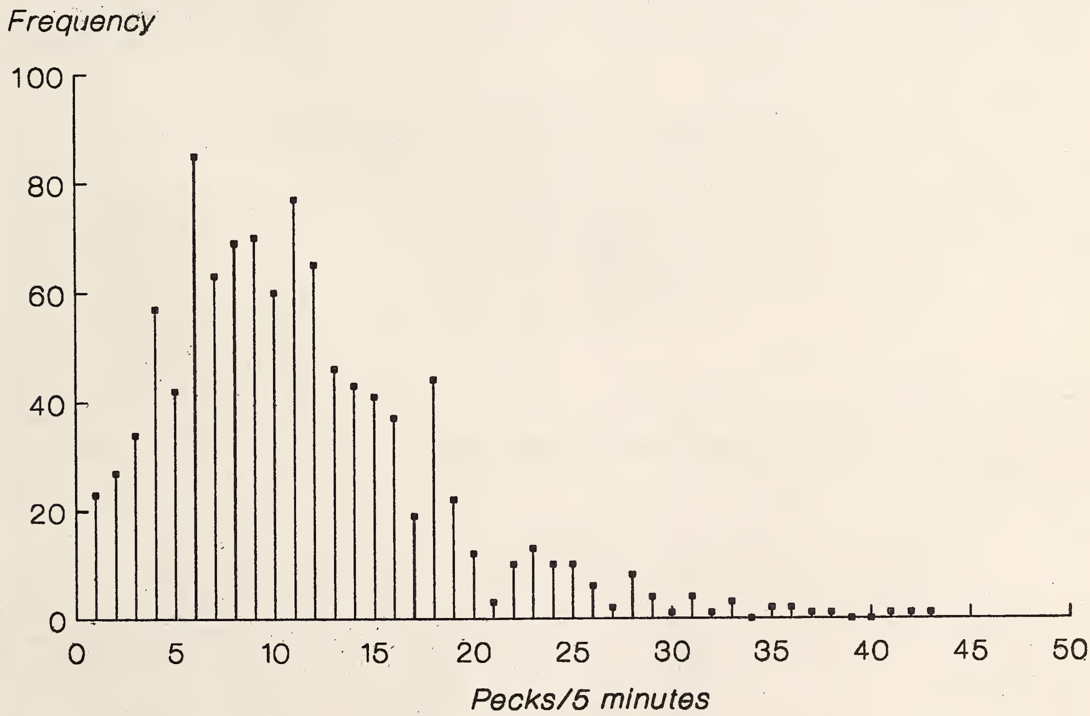


Fig. 6. Frequency distribution of peck rate in the great Indian bustard at Karera.

TABLE 4
PECK RATES IN THE OPEN SCRUB AREAS OF DIFFERENT PLOTS

Name of the Plot	Mean	SD	No. of samples
Turkani	11.14	7.35	416
Hanuman-jhoora	12.38	8.20	31
Rasori	10.95	6.22	252
Kundpatha	10.54	6.62	133
Karawwa	11.31	4.89	94
Outside Plantation	8.18	2.79	11
Baigawan	12.57	7.66	45

TABLE 5
PECK RATES OF DIFFERENT SEXES AND DIFFERENT INDIVIDUALS IN OPEN SCRUB AREAS ONLY

Sex/Individuals	Mean	SD	No. of samples
Sex			
Male	11.5	7.05	589
Female	10.6	6.41	433
Individuals			
Alpha male	12.11	7.14	288
Beta male	11.89	7.46	167
Juvenile male	9.97	5.01	109
Mother (with juvenile)	12.44	7.36	98
Breeding hen	6.69	2.71	59

TABLE 6
SCHEFFE'S TEST TO FIND THE SIGNIFICANCE BETWEEN VARIATIONS IN PECK RATE IN DIFFERENT SEXES AND DIFFERENT INDIVIDUALS

	NBF	MOF	BF	ALM	BEM	JUM
NBF	0.00	4.41	18.84*	5.51	2.77	1.25
MOF		0.00	27.83*	0.18	0.43	7.19
BF			0.00	32.95*	26.92*	9.42
ALM				0.00	0.13	8.31
BEM					0.00	5.53
JUM						0.00

*$P < 0.01$
NBF = Non-breeding female, MOF = Female with chick, BF = Breeding female, ALM = Alpha male, BEM = Beta male, JUM = Juvenile male.

TABLE 7
PECK RATE OF SOLITARY AND NON-SOLITARY BIRDS IN THE OPEN SCRUB

Sex	Mean	SD	No. of samples
Solitary female	12.78	8.84	194
Non-solitary female	12.17	6.12	245
Solitary male	12.30	8.76	272
Non-solitary male	11.12	7.15	317

Discussion

Although the great Indian bustard is an opportunistic feeder, its preferred food is insects, chiefly Orthopterans and Coleopterans. Numerous studies such as Parker (1929), Andrewartha and Birch (1954), Uvarov (1931), Edwards (1960), Dempster (1963) and Ali (1978, 1980) have shown seasonal fluctuations in the population of insects (grasshoppers), depending on the weather conditions, chiefly precipitation and temperature. In our study areas also, seasonal fluctuation of the grasshopper was noticed (Fig. 4), with maximum numbers during summer and/or monsoon and the minimum in winter.

The bustard shifts its food-preference seasonally depending on the more commonly available food items. The timing of the bustard's nesting season at Karera was seen to synchronise with the increase in abundance of grasshoppers (Rahmani 1989).

Food items in the bustard diet identified by earlier workers are listed in Table 1. Insects, mainly grasshoppers and beetles, are perhaps the most important animal constituents in the diet. The habitats of the bustard (grasslands and open scrubland) are suitable for picking up insects during foraging. While walking the bustard flushes various types of insects, among which Hymenoptera, Orthoptera, Coleoptera and Lepidoptera are generally eaten. In addition to insects, other organisms such as lizards and small snakes are also opportunistically eaten. Hume and Marshall (1879) reported that a complete egg of quail (*Coturnix*) was found from the stomach of a bustard. Our tame bustard (age > 1 year) at Rollapadu in Andhra Pradesh easily picked up two sandgrouse *Pterocles exustus* eggs from the nest (Manakadan and Rahmani 1990).

The two main advantages of foraging in a flock are a higher probability of detecting a predator by vigilance of companions, and improved location and chance of catching prey (Bertram 1978). Therefore, foraging rate of an individual in a flock should be more than in a solitary bird. We did not find any difference in the peck rates between a solitary and a non-solitary female, and very little difference between a solitary and non-solitary male, indicating that even when the bustard is in a flock, it feeds independently; flushing of live prey by other members of a flock ('beaters') does not play a significant role in locating food. Similarly, predator detection by companions, thus leaving more time to search for food, also does not contribute significantly while foraging.

The peck rate of a hen that has laid an egg or is accompanied by a small chick was significantly lower than in hens which were not breeding (Tables 5, 6). The main reason could be that a hen with an egg or a small chick is constantly looking for danger, and hence has less time for foraging. We found that adult bustards are not vulnerable to most ground predators (especially during daytime) such as wolf *Canis lupus*, jackal *Canis aureus* and fox *Vulpes bengalensis*. However, an egg or a chick is always in danger from these and many other smaller predators also; therefore a breeding hen has to be constantly alert .

The difference in peck rate of males and females could be due to two reasons: (1) Difference in the behaviour of the two sexes – females were more timid and easily alerted than males, and therefore spend more time looking for danger than do males. (2) Sexual size dimorphism – as males are larger and almost twice the weight of females, they need more food, hence higher peck rates.

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ON THE IDENTITY AND NOMENCLATURE OF CERTAIN INDIAN *IXORA* (RUBIACEAE)[1]

D.B. Deb and R.C. Rout[2]

The revision of the genus *Ixora* L. (Rubiaceae) by Bremekamp (1937a) has been criticised by Corner (1941) in his study of the Malayan *Ixora.* Corner observed "the size and hairiness of corolla and even the shape of the petals I find to be most variable and, for the majority of the Malayan species, by no means specific. From the most recent works on the genus (Craib 1934, Bremekamp loc.cit.), the impression is gained that many new species can be blocked out from the old and that minute differences in hairiness, leaf size or shape and length of corolla tube suffice to define them. But I am certain that this view is mistaken, and if followed, must lead to the making of so many species that the classification of the genus will become impossible. Such splitting, based on relatively few herbarium specimens, merely obscures the issue which is to have names for the well defined groups of individuals".

Ixora chinensis Lam., *I. coccinea* L., *I. javanica* (Bl.) DC., *I. grandifolia* Zoll. & Mor., *I. nigricans* Wt. & Arn. etc. treated therein by Corner (loc.cit.) are very common and widespread in India. On the other hand, field studies conducted by the senior author (D.B.D.) of this note during the last three decades and that of the other author (R.C.R.) for the last four years support the observations of Corner. Again, specimens available in herbaria after the study by Bremekamp (loc. cit.) and Corner (loc.cit.) tend to bridge the gap in knowledge on variability of some species. Husain and Paul (1989) did not examine many specimens in CAL and K as there is no indication of their study on the herbarium specimens to which the authors of this note had access.

In the light of these facts we are in a position to comment on the status of several species thereby reducing them to synonyms. Those reduced to synonyms do not deserve infraspecific status.

1. *Ixora goalparensis* Bremek. (1938 : 336) was postulated on the basis of *U.N. Kanjilal* 5758, collected from Goalpara district of Assam. This was distinguished from *I. subsessilis* in much longer calyx teeth. *I. longibracteata* Bremek. (1959: 371) was distinguished from *I. goalparensis* Bremek. in longer bracts, bracteoles and calyx teeth. A study of the protologue and type specimens along with other specimens of both the species suggests that *I. goalparensis* and *I. longibracteata* differ neither from each other nor from *I. subsessilis* in any respect. The latter is variable in the length of bracts, bracteoles, calyx teeth and corolla tube, thereby covering up the distinctions noted by Bremekamp (loc.cit.). Hence *I. goalparensis* and *I. longibracteata* are treated as synonyms as follows. They do not even deserve any infraspecific status.

Ixora subsessilis Wall. ex G. Don, Gen. Syst. 3: 572. 1834 (Lectotype : Jaintiapore (Jowai), May 1826, *F. De Slva s.n.* ex Wall. Cat. 6139 A CAL!). Hook. f., Fl. Brit. Ind. 3: 139. 1880; Husain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 119. 1989.

I. oxyphylla Wall. ex G. Don, Gen. Syst. 3: 572. 1834 (Type: *Wall. Cat.* 6159 & 6159 A CAL!)

I. goalparensis Bremek. in Journ. Bot. 76: 336. 1938; Husain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 117. 1989 (Type : Assam, Goalpara dist., Guma Reserve, 22. 5. 1916, *U.N. Kanjilal* 5758 holo. DD!, photo and iso. CAL!), Syn. Nov.

I. longibracteata Bremek. in Ind. For. 85(7): 371. 1959; Hussain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 119. 1989 (Type: Bangladesh, Chittagong. Hill Tracts, Tintilla, 16.5.1939, *T. V. Dent* 14, holo. DD!, photo CAL! Syn. Nov.

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Husain and Paul (1989 : 119) while selecting *Wall. Cat.* 6139 A CAL as the lectotype misinterpreted Wall. Cat. entry and considered that this specimen was collected by *De Silva & W. Gomez.* This is not correct. The specimen concerned in CAL was collected by *F. De Silva* in May 1826 from Sylhet mountain which is in fact Jowai, now in Meghalaya.

2. *Ixora andamanensis* Bremek. (1937b: 260) was described on the basis of *C.E. Parkinson* 140. It was probably wrongly compared with *I. lacei* and *I. ackringae*. Rather it agrees with *I. barbata* Roxb. wherein corolla tube varies in length from 20 to 35 mm and the throat is bearded to glabrescent. In *I. andamanensis*, corolla tube is 15 to 17 mm and the throat is glabrous or glabrescent. Thus it gets merged with *I. barbata* and does not deserve any infra-specific status.

I. katchalensis Husain & Paul (1984 : 153 - 156) was postulated on the basis of four gatherings : *P. Chakraborty* 1134 & 5305, *N. Bhargava* 5031 and *N. P. Balakrishnan* 5325. It was distinguished from *I. barbata* Roxb. in "distinctly longer petiole, more lateral nerves, different inflorescence pattern, number of flowers per head and structure of stigma". A study of protologue along with the types (holo. and iso.) suggests that, *I. katchalensis* does not differ from *I. barbata* in any respect and agrees with it. The stigma described as "slightly cleft in the middle by 1/3 from above" is found to be bifurcated to two linear stigmatic arms. Hence, *I. katchalensis* does not stand as a distinct species, or does not deserve any infraspecific status.

I. andamanensis and *I. katchalensis* are reduced here to synonyms as follows.

Ixora barbata Roxb. (Hort. Beng. 10. 1814 *non. nud.* &) ex Smith in Rees, Cycl. 19. no. 6. 1811; Roxb. Fl. Ind. 1: 394. 1820 (Type: Andaman Islands. Cultivated at H.B.C. (CAL), *Roxburgh s.n.* holo. K!, photo CAL!); Hook.f., Fl. Brit. Ind. 3: 148. 1880; Hussain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 146. 1989.

I. andamanensis Bremek. in Journ. Bot. 75: 260. 1937; Husain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 94. 1989 (Type: Andaman Island, Havelock, 1914, *C.E. Parkinson* 140 holo. DD!, photo CAL!), Syn. Nov.

I. katchalensis Husain & Paul in Blumea 30: 153-156. 1984 & Journ. Econ. Taxon. Bot. Addl. Ser. 6: 153. 1989 (Type: India, Andaman & Nicobar Island, North Nicobars, Katchal Is., sea level, 22 Apr.1974, *P. Chakraborty* 1134 PBL), Syn. Nov.

3. Husain & Paul (1986, 1989) proposed *I. beddomei*, *I. manantoddi* and *I. mercaraica*, on the basis of a single gathering each, collected from the same locality in Wynaad district of Kerala, and the adjacent locality Mercara of Coorg, now in Karnataka. They distinguished these species from *I. lawsonii*, which was also originally collected from these localities.

Husain and Paul do not appear to have examined the type specimen of *I. lawsonii* located at K and MH as no sign of exclamation is added after the name of herbaria where they are extant nor they seem to have studied the original description properly. In describing this species they say "habit unknown... stipules not seen... anthers and filaments not seen". In 'distribution and ecology' they say "populations are usually encountered in ghats of Wynaad, Manantodde and Coorg", but no specimens has been cited. If populations are encountered then the habit and stipules cannot remain unknown. The notes on the species on p. 133 are ad verbatim copied from Gamble's original publication.

Gamble stated inter alia "Arbor vel frutex elatus ... Folia ..... basi rotundata, juniore aliquando attenuata; nervi lateralis.....10-16; stipules ovatae, apiculo dorsali longi subulata ..... stamina recurva, filamentis brevibus, antheris linearibus". This appears to be a rare species. In spite of the area having been thoroughly explored, only one collection has been made after the original collection.

These species differ from *I. lawsonii* only in slight pubescence of the leaf, a character that may arise due to ecological variation. Moreover for this slight variation in hairiness only, these taxa cannot be distinguished even in infraspecific status.

Ixora beddomei is distinguished from *I. lawsonii* in foliis basi acutis, calycum tubis pubescentibus et corollae tubis 17-17.5 mm longis. In *I. lawsonii*, leaf base varies from acute to obtuse or rounded. The calyx is pubescent in the same specimen (*Wight s.n.* K!) and corolla tube is 7-20 mm long, smaller size is evident in bud stage. Thus *I. beddomei* cannot stand as a distinct species.

Type specimens of *I. mercaraica* (*Hohenacker* 439 a) is too poor to be the basis of a species. It is an incomplete specimen with only a pair of leaves at the base of peduncle, which is normally variable from those of the other leaves in form, length of the petiole and hairiness. The peduncle may be pubescent when the remaining part of the stem is glabrous. In *I. lawsonii*, petiole varies from 2 to 10 mm. Calyx tube pubescent outside, calyx teeth 3-7.5 x 0.5-1.0 mm, pubescent outside, glabrous within. Moreover, a species should not be distinguished on the basis of slight differences in quantitative characters like length of petiole, bracteoles and calyx lobes. Thus *I. mercaraica* also does not stand.

I. manantoddi agrees with *I. lawsonii* in all respects, except hairiness of young branches and leaves beneath. So it does not stand as a distinct species.

I. beddomei, *I. mercaraica* and *I. manantoddi* are reduced to synonyms as follows:

Ixora lawsonii Gamble in Kew Bull. 1920: 247. 1920; Husain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 131. 1989 (Type: Kerala, Wynaad dist., Manantodde, ± 1000 m, Jan. 1884, *M.A. Lawson* 43 lecto. K!, photo CAL!, Isolecto. MH!).

I. beddomei Husain & Paul in Candollea 41 (1): 87. 1986 & Journ. Econ. Taxon. Bot. Addl. Ser. 6: 124. 1989 (Type: Kerala, Wynaad, 1885, *R.H. Beddome* 3909 holo. BM!, photo CAL!, iso. K), Syn. Nov.

I. mercaraica Husain & Paul in Candollea 41(1): 88. 1986 & Journ. Econ. Taxon. Bot. Addl. Ser. 6: 135. 1989 (Type: Karnataka, Mercara, 1847, *Hohenacker* 439 a, holo. BM!, photo CAL!, iso. K), Syn. Nov.

I. manantoddi Husain & Paul in Pl. Syst. Evol. (MSS) & in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 133. 1989 (Type: Kerala, Wynaad, Manantodde, *R.H. Beddome* 3908, holo. BM! photo CAL!, iso. K), Syn. Nov.

4. *Ixora capituliflora* Bremek. (1937 b) was based on *C.E. Parkinson* 1198 and *J.H. Lace* 2818 from Andaman Islands. The author distinguished this species from three distantly related species: *I. merguensis* Hook.f. in calyx lobes longer, glabrous, corolla not bearded; from *I. korthalsiana* Kurz in corolla not bearded and from *I. kurziana* (Teysm. & Binn.) Kurz in leaves smaller, inflorescence subcapitate, calyx lobes longer. On examination of types and other collections from Andaman Islands, it is observed that this species is not distinguishable from *I. finlaysoniana* Wall. ex G. Don. The leaves of *I. finlaysoniana* are narrowly obovate or oblanceolate, obtuse or mucronulate at apex, atenuate at base, whereas in Andaman specimens (*I. capituliflora*), it is variable from elliptic to -oblong, -obovate or -lanceolate. The cyme is also variable, subcapitate to distinctly branched corymbose one. So, *I. capituliflora* Bremek. does not stand as a distinct species and is reduced to a synonym as follows. It does not even deserve any infraspecific status.

Ixora finlaysoniana Wall. ex G. Don, Gen. Syst. 3: 572. 1834 (Type: East India, *Finlayson s.n.* ex *Wall. Cat.* 6166 K-WH microfiche CAL!).

I. capituliflora Bremek. in Journ. Bot. 75: 297. 1937; Husain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 124. 1989 (Type: Andaman Islands, 1916, *C.E. Parkinson* 1198, holo. & iso. DD!, photo & iso. CAL!), Syn. Nov.

5. *Ixora roxburghii* Balakr. (1981 : 232) was proposed as a substitute name for *I. villosa* Roxb. (1814 & 1820) as the latter was a later homonym of that of Poiret (1813), which represents a synonym of *Pavetta villosa* Vahl. The name *I. roxburghii* Balakr. was accepted by Husain and Paul (1989 : 102). However, they overlooked that *I. roxburghii* Balakr. is also a later homonym of that of O. Kuntze (1891), which represents a synonym of *Pavetta tomentosa* Roxb. ex Smith. So, this name is rejected as per Art. 64 of Interna-

tional Code of Botanical Nomenclature. Consequently a substitute name is proposed as follows:

Ixora balakrishnii Deb et Rout, *nom. nov.*

Ixora villosa Roxb. (Hort. Beng. 10. 1814, *nom. nud.* &) Fl. Ind. 1: 382. 1820, *non* Poir. 1813 (Type: Sylhet, *Roxburgh s.n.* ex Wall. Cat. 6137 A, CAL!, K); Hook.f., Fl. Brit. Ind. 3: 144. 1880.

I. roxburghii Balakr. Fl. Jowai 1: 232. 1981, *non* O. Kuntze 1891; Husain & Paul in Journ. Econ. Taxon. Bot. Addl. Ser. 6: 102. 1989.

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THE LAND TORTOISE IN NEPAL : A REVIEW [1]

J. Frazier [2]

(With a plate and a text-figure)

Little is known of land tortoises (family Testudinidae) in the Indian subcontinent, and the information available from Nepal is remarkably muddled. Three very different species have been reported, but there are numerous unsupported statements and several claims of misidentification. Many authors have simply repeated (perhaps in a modified form) the statements of earlier publications without critically examining specimens or information. The present note reviews published and other information on land tortoises in Nepal, concluding that the only species definitely recorded in the country is *Indotestudo elongata*.

Introduction

Three species of land tortoise (Testudinidae) have been claimed to occur in Nepal: *Geochelone elegans* (Schoepf), *Testudo horsfieldii* Gray and *Indotestudo elongata* (Blyth). The first named is found from north-eastern Rajasthan (western India) south to Sri Lanka (Iverson 1986 : 140; Frazier in prep.); hence, a Nepalese record would represent a major range extension.

Testudo horsfieldii is known to occur from the Caspian and Aral areas of West Central Asia (Shammakov 1981 : pl. 3; Yatyayev 1985 : pl. 4), eastward to Baluchistan and Afghanistan (Smith 1931 : 146, Hora 1948 : 296, Iverson 1986 : 172) and even to Xinjiang province of western China (Zhao 1973). Auffenberg (1974 : 195) suggested that *T. horsfieldii* occurs in the environs of Dehra Dun, Uttar Pradesh, India, west of the western border of Nepal, but no evidence has ever been presented to support this claim. It is, therefore, remarkable that the Nepalese 'record' (see below) is the easternmost for this species.

The third species recorded from Nepal, *Indotestudo elongata*, is known to occur from Indo-China westward to India (Smith 1931, Hoogmoed and Crumly 1984 : fig. 3, Iverson 1986 : 156), and as far west as Corbett National Park, Uttar Pradesh, India (Ross and Crumly 1983). This geographic range stretches across the east-west extent of the southern extreme of Nepal (Fig. 1).

Zoogeographically, *G. elegans* is typical of the central Indian and Deccan areas of the Indian subcontinent, *T. horsfieldii* is part of the Palearctic fauna, and *I. elongata* is characteristic of the Indo-Chinese subregion of the Oriental Region (Smith 1931 : 16, Hora 1948 : 296, Jayaram 1949 : 397, 1974 : 545-546). Species from all of these zoogeographic regions, subregions or areas are known to occur in the herpetofauna of Nepal (Swan and Leviton 1962, Waltner 1973a, b, c, d); hence, *a priori* any, or all, of the three above-named species of land tortoise could occur in Nepal.

The confusion stems mainly from the (mis)identification of a drawing donated by B.H. Hodgson to the British Museum (Natural History) (BM[NH]) in the mid-19th century. There is a long history of problems regarding drawings of herpetological specimens from this region (see Webb 1980), and the Hodgson tortoise drawing is remarkable in this respect.

Discussion

Geochelone elegans (Schoepf)

There is only one record of this tortoise from Nepal. Laurie (1978 : 41) stated that "Reptiles and amphibians recorded in Chitawan include the marsh crocodile or mugger, the gharial, two species of monitor lizards, the starred tortoise and several species of lizards, snakes and frogs." The common name 'starred tortoise' is the most usual English name for *G. elegans* (e.g. Gunther 1864:4, Daniel 1983 : 30), and it is not regularly used for any other species in Asia.

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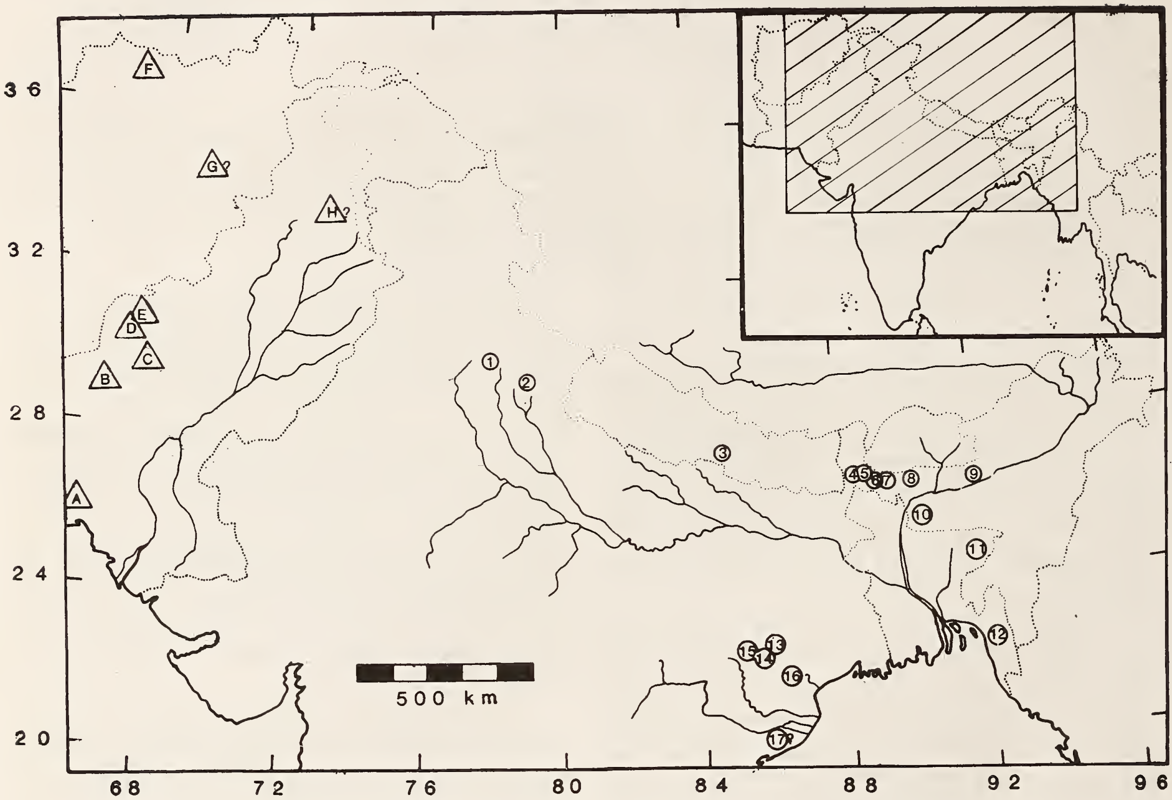

Fig. 1. The northern area of the Indian subcontinent, showing locality records for *Indotestudo elongata* (circles 1-17) at the western limit of its range, and also locality records of *Testudo horsfieldii* (triangles A-H) at the eastern limit of its range. See Appendices 1, 2 for details of each locality record. Dotted lines show political boundaries; only major river systems are indicated.

In the absence of any other supporting evidence, this record must be rejected as an error (indeed, the appendix of reptiles in Chitawan in Laurie's (1978) thesis lists *Testudo elongata*). No further mention of *G. elegans* will be made in the present discussion of Nepalese tortoises.

Testudo horsfieldii Gray

The first species of land tortoise reported from Nepal was *T. horsfieldii*. Gunther (1861 : 214) listed and described 41 species of reptiles and amphibians collected (either as actual specimens or as drawings) by B.H. Hodgson. The first species in Gunther's list was *Testudo horsfieldii,* for which he simply stated "one coloured drawing," indicating that he had not examined a biological specimen. In fact, this 'specimen' (Plate1), commissioned by Hodgson, is the root of nearly all misunderstanding regarding land tortoises in Nepal; it is, therefore, discussed in detail below.

It is noteworthy that three years later, Gunther (1864 : 8), evidently less confident about the identity of this drawing, wrote "A drawing made

from a Nepalese specimen, and presented by B.H. Hodgson to the British Museum, *appears* to represent this tortoise (*T. horsfieldii*); *if* the determination be correct, this species (*T. horsfieldii*) would extend to Nepal" (italics added). For some reason, Gunther was no longer simply stating that *T. horsfieldii* occurred in Nepal, but instead he qualified his listing of this species by suggesting that – on the basis of a drawing – it may extend into Nepal. He pointed out his unfamiliarity with *T. horsfieldii*, stating that he had seen only one specimen (1864 : 8); clearly, he was not certain of the identity of the species represented by the drawing.

Smith (1931 : 146), in his classic review of the chelonians of British India, made no mention of *T. horsfieldii* in Nepal, and he did not even cite Gunther's papers (1861, 1864) under the discussion of this species. However, he stated (p. 143) that Hodgson's drawing was of *Testudo elongata*, an earlier name for *Indotestudo elongata*. The fact that Smith (1931) included no mention of the previous (mis)identifications made by Gunther (1861: 218, 1864:8) left his re-identification as a source of confusion. One might surmise that in deference to the grand old guru of herpetology, Albert Gunther, Smith chose not to mention his elder's error.

Whatever his reasons, Smith's (1931) omission of any mention of a misidentification or his re-identification was seized upon as evidence that the identity of the land tortoise in Nepal was in a state of confusion. Swan and Leviton (1962 : 110) flatly rejected Gunther's identification by listing "*Testudo horsfieldi*, Gunther, 1861, p. 214 (Nepal); 1864, p. 7 (Nepal)" as a synonym for "*Testudo* (=*Indotestudo*) *elongata*". They went on to claim that "It is uncertain whether Smith considered Hodgson's drawing (which Gunther described as *T. horsfieldi, supra cit.*) to be *T. elongata* or whether Smith's reference is in error.

This treatment by Swan and Leviton (1962) is itself not without shortcomings. They failed to take into account that Gunther's second listing (1864: page 8' which deals with Nepal, not page 7 as they indicated) was a tentative identification, clearly including simple and obvious reservations. Thus, to list '*T. horsfieldi* Gunther 1864 : 8' as a synonym of *I. elongata* is an oversimplification and misrepresentation of what Gunther had in fact written. In addition, Smith's (1931 : 143) meaning could not be clearer in his identification of the Hodgson drawing, and there is no reason to claim that he was confused. It is remarkable that, in spite of these identifications, re-identifications and criticisms of earlier authors, there is no evidence given by Swan and Leviton (1962) that they ever examined either a specimen of a land tortoise from Nepal or the root cause of all the confusion and discussion – the drawing presented by Hodgson to the BM (NH)! (Levitson, pers. comm. stated that they had not seen the drawing.)

In his summary of the reptiles of the Himalaya, Waltner (1973a, b) made no mention of *T. horsfieldii*. He did list *I. elongata*, evidently following Swan and Leviton (1962). Auffenberg (1974 : 195) suggested that *T. horsfieldii* occurs at Dehra Dun, to the west of Nepal, and "will eventually be found to inhabit much of the foothill area of the Himalayan mountains." However, he now believes (*in litt.* Dec. 1987) that the species involved is *Indotestudo elongata*, not *T. horsfieldii*.

Jayaram (1974 : 548) stated that "*Testudo horsfieldi* is widely distributed from the Caspian and Aral Seas to the north-western corner of India". There is absolutely no evidence that *T. horsfieldi* has ever been recorded in the territory known as 'India.' This error was apparently caused by Jayaram having lifted Smith's (1931 : 146) description of the range of this species, which specified ".... to the north-western corner of British India." Omitting the word 'British' completely changes the area from the British India of the days of the Empire (which included Baluchistan, known to harbour *T. horsfieldi*) to modern India (which has never included Baluchistan).

The most recent mention of *T. horsfieldii* in Nepal is that of Majupuria (1981-82 : 152); he stated that "*Testudo horsifieldi* (sic) is represented in Hodgson's collection." No reference or sup-

porting evidence was given, but this claim was evidently based on Gunther (1861 : 218). Majupuria (1981-82 : 174) stated that *T. horsfieldii* was "Reported by Prater, 1928"' in Nepal, but Prater's BOOK OF INDIAN ANIMALS, first published in 1928 and now in its fourth edition, although an invaluable source book on mammals of the Indian subcontinent, does not deal with tortoises or other reptiles. Hence, Majupuria's (1981-1982) statements about *T. horsfieldii* occurring in Nepal are without support.

Indotestudo elongata (Blyth)

The first mention of this species in Nepal is that of Smith (1931 : 143): "Hodgson obtained a specimen in the Saul forests of Nepal, and has left a fine coloured sketch of it in his collections of drawings." The mention of Saul forests implies that Smith had examined the drawing in question, for the words 'Land tortoise of Saul Forest' are pencilled on the bottom left, and this information has not appeared in previous – or subsequent – publications. In addition, the evaluation of the drawing as "fine" is further support for his having examined it because it is a realistic depiction (Fig. 2).

The next mention of *I. elongata* is that of Swan and Leviton (1962 : 110). As stated above, these authors rejected Gunther's (1861 : 218, 1864 : 8) accounts of *T. horsfieldii* and doubted the certainty of Smith's (1931 : 143) identification of *T. elongata*.

Yet, it was not explained how they arrived at their own identification, with no mention of having examined any relevant material. Nevertheless, they (1962 : 110) stated that *I. elongata* is found in central Nepal, presumed (p. 107 footnote 2) on the premise that Hodgson's material came mainly from the area around Kathmandu. More remarkable, they listed (Table 1, p. 138) this tortoise as known to occur in "Sikkim-Darjeeling"; no support for this claim was given, and none is known (see below). Swan and Leviton (1962 : 138) also predicted that *I. elongata* occurs in eastern Nepal, and they concluded that the species could be characterisedashavinganIndo-Chinesedistributionbut extendingintotheeastern Himalaya.

Waltner (1973b : 29), in his review of Himalayan reptiles, listed *Testudo* (= *Indotestudo*) *elongata* as recorded from "Sikkim, Darjeeling, Teak forests of Nepal ...." and from 0 to 9,000 feet (0 to 2,740 m) in altitude. The distributional data appear to be based on Swan and Leviton (1962), but the occurrence of this tortoise in teak forests or at any altitude in Nepal is unsupported by any published information. Waltner (*in litt.* 20 Oct. 1987) stated that he had no firsthand experience with chelonians in this region. Furthermore, teak *Tectona grandis* does not naturally occur as far north as Nepal (Champion and Seth 1968, Stainton 1972).

It is important to point out that there is no evidence that *Indotestudo elongata* occurs in Sikkim and Darjeeling (c.f. Swan and Leviton 1962, Waltner 1973b : 29), an error which has evidently arisen from the inappropriate use by Swan and Leviton (1962 : Table 1) of 'Sikkim-Darjeeling' to refer to Sikkim and all of North Bengal (including Darjeeling, Jalpaiguri and Koch Bihar districts). There are several records of *I. elongata* from Jalpaiguri dist. (Smith 1931 : 96, Das 1988 : 21, 22), but none are known from Darjeeling or Koch Bihar districts or from Sikkim.

The name *Testudo elongata* appears in an appendix of the reptiles of Chitawan Park, Nepal, in Laurie's thesis (1978) on the rhinoceros *Rhinoceros unicornis*. However, this was apparently based on previous publications, not original data; and, as stated above, there is confusion in the text of the thesis as to which tortoise was being referred to.

Majupuria (1981-82 : 152, 174) stated that *Testudo* (= *Indotestudo*) *elongata* is recorded from Central Nepal, in Bagmati and Narayani zones. Although this is the first attempt to provide specific locality data for land tortoises in Nepal, it is not stated on what information these claims were based. A photograph published by Majupuria (1981-82) clearly shows three *I. elongata* together, but no indication of where these tortoises were collected is given; the caption

simply says "Land tortoises are distributed in Central Nepal."

Clearly, it has been common for authors to reiterate the Nepalese 'record' of Smith (1931 : 143). After it was repeated by Biswas *et al.* (1978), Ross and Crumley (1983) referred to it. However, as the last named authors pointed out, there is no exact locality for this 'record.'

Of the half dozen authors who have written about land tortoises in Nepal, none (with the possible exception of Majupuria) appears to have examined a specimen from that country; and only Gunther and Smith had obviously examined the drawing donated by Hodgson to the BM (NH).

Hodgson's drawing (Plate 1)

Smith (1931 : 5) gave a brief biographical account of Brian (or Bryan) Houghton Hodgson, and other details are presented by Archer (1962 : 11-12, 80) and Sawyer (1971 : 140). In short, Hodgson commissioned collections and drawings of local animals while based in Kathmandu from 1820 until 1844. A folio of 29 drawings bound into one volume is in the library of the BM (NH).

Only one Chelonian is depicted in this collection (Plate 9), and the coloured drawing of the land tortoise clearly illustrates several important features: nose and sides of the head are pink; head scales posterior to the frontal are relatively small in size; five claws are on each of the fore feet; the carapace is conspicuously more elongate than wide; there are conspicuous black, irregular blotches on each scute of the carapace; no spurs are evident in the area of the thighs (although they might not be seen from the angle shown); and a spur is conspicuous at the end of the tail. With the exception of black blotches on the carapace (which can occur in both species), all of these features are consistent with – if not diagnostic of –*Indotestudo elongata*, and inconsistent with *Testudo horsfieldii.*

At the bottom of the drawing are several annotations. 'Land Tortoise of Saul Forest. nat. size.' is pencilled in at the far left ('Saul,' or more commonly 'Sal,' is the tree *Shorea robusta*). At the centre, in what appears to be different handwriting is '? Testudo indica.' That name, as well as the question mark, has a line through it, and 'Horsfieldii' is pencilled at the right of 'indica'; this appears to be in a third hand.

Directly under the pencilled species names are three lines of North Indian script: a pencilled line and below, in another hand, two inked lines. The pencilled line (with apparently four characters) is indecipherable. The literal translation of the two inked, Hindi-like, lines is 'R.V. Motiya Voli' and 'Kachhuwa.' R.V. Motiya Voli appears to be the name of a person. The last line, Kachhuwa, means turtle.

At the far right of the base of the drawing, in pencil, are two more lines of Hindi-like script; these appear to be in two additional hands. The upper line, of three characters, may be an abbreviated signature of R.V. Motiya Voli. However, it could also translate to 'Sugali' (or 'Sungali') the significance of which is unknown. In the bottom right corner is 'A.V. Lapcha' (or 'Zapcha'); this is evidently a person's name – probably a Nepali (although Archer (1962 : 11) stated that Hodgson hired Indian assistants). Which, if any, of these names apply to the artist or collector is unknown.

In summary, it appears as if at least five different people have annotated this drawing: three in English and between two (in the case that one person signed in full and then with initials) and four in Hindi, or another north Indian script. Some of the annotations are clearly attempts to identify the drawing, others may indicate who was involved in its execution. The comments relevant to habitat and size are likely to have been written soon after the drawing was given to Hodgson, and the north Indian script was almost certainly added while the drawing was in 'British India'.

On the back side of the drawing, in pencil, is the list of measurements (apparently in inches and fractions of inches, except for one value in pounds), as shown in Table 1.

Records in the India Office Library (Archer 1962 : 12) and the BM (NH) library, archives and publications show that a number of well known herpetologists had corresponded with B.H. Hodgson and examined material donated by him,

TABLE 1
MEASUREMENTS INDICATED ON HOGDSON'S DRAWING

Length of shell	0.11.0
Width	7 1/2
Height	– 5 –
Length of head	– 2 3/4
Width of head	– 1 5/8
Length of leg, fore, as fully exeserted (sic)	4 1/4
Length of leg, hind, as fully exeserted (sic)	4 1/2
Weight	6 lbs
Tail to vent	1 5/8
Tail to dorsal shell	2 1/4

including T.E. Cantor, J.E. Gray, A.C.L.G. Gunther, Dr Hooker, Dr T. Horsfield, and M.A. Smith. However, neither Andrew Stimson (of the Herpetology Section) nor the Librarian of the BM (NH) could identify any of the handwriting on the tortoise drawing; it did not match handwriting samples of either Gunther or Smith.

Archer (1962 : 80) stated that light pencilled inscriptions on some of Hodgson's drawings deposited in India House (India Office Library) were in Nagari. On the basis of this she suggested that the draughtsmen were Hindus from Bihar or United Provinces (now Uttar Pradesh).

It is probably of little significance that the Hodgson drawing was originally named '? *Testudo indica*,' for very little was known of chelonians in the Indian region during the last century, and there was tremendous nomenclatural confusion. That Boulenger (1889 : 172) regarded *T. indica* as an extinct species from Mauritius, and considered the name as a synonym for one of the Galapagos tortoises ('*Testudo nigrita*' = *Geochelone elephantopus*) (Boulenger 1889 : 169) shows how confused the species names were (see also Theobald 1870 : 674 for a criticism of the use of the species *indica* for Indian species of tortoises). There is no reason to further confuse the question of which tortoise is in Nepal by considering these island species.

Of more importance is: who re-identified the drawing as *T. horsfieldii* ? However, it may never be possible to determine who annotated this drawing.

Assuming that the values on the back of the drawing are reliable measurements of the specimen depicted on the front, its identity is even more clear. When compared with measurements of specimens of the two species in question (Frazier, unpublished data), the dimensions of the shell — 11" (28 cm) long; 7.5 " (19 cm) wide; and 5 " (13 cm) high — are consistent with *Indotestudo elongata* and inconsistent with *Testudo horsfieldii.*

Recent specimens and records from the terai: In 1974 C.A. Ross (Ross and Crumly 1983) found a specimen of *Geochelone* (= *Indotestudo*) *elongata* "in the vicinity of Gairal Forest Rest House, Corbett National Park, about 25-30 km north-west of Ramnagar." This locality (Fig. 1) is about 75 km west of the Nepalese border, in Garhwal district, Uttar Pradesh.

On 16 April 1985, Dr J.C. Mitchell found the remains of a shell of *Indotestudo elongata* (USNM 267020) at Sauraha, Chitwan, Narayani district, Nepal (Fig. 1). Although incomplete and dog-chewed, this appears to be the only Nepalese specimen of this species deposited in a museum (although it could not be found in September 1988).

Indotestudo elongata apparently also occurs in the vicinity of Dehra Dun, Uttar Pradesh, India, to the west of Nepal (Fig. 1). Dr R.K. Bhatnagar, formerly in charge of the Herpetology Section of the Zoological Survey of India (ZSI) station in Dehra Dun, wrote (*in litt.* 4 December 1987) that "before 1970" he collected a gravid female tortoise (unidentified) from Phandowala, Dehra Dun Siwaliks, now Rajaji National Park; the specimen was left at the ZSI station. Dr W. Auffenberg reported (*in litt.* December 1987) that he has "seen a slide of a specimen photographed near Dehra Dun and it is *elongata*". Apparently, the slide came from Dr. R.K. Bhatnagar.

Dr R. Tilak, Officer-in-charge of the ZSI station, Dehra Dun, reported (*in litt.* 5 February 1988) that they had no trace of any specimen of *T. horsfieldii*, but did have a mounted specimen of *I. elongata.* Measurements and photographs of this specimen, provided by B.C. Choudhry (*in litt.* 13 March 1989), show that it is an adult female *I.*

elongata (curved carapace measurements: length 27.3, width 22.7 cm.; 17 to 18 growth rings), with very little black on the carapace.

These recent records show that *Indotestudo elongata* occurs along the Terai, or Himalayan foothills, as far west as Dehra Dun. This further supports the occurrence of this species in Nepal.

Conclusions

There is no evidence to support the contention that *Testudo horsfieldii* occurs in Nepal. The occurrence of *Indotestudo elongata*, although confused by more than a century of misidentification, is traceable back to the first evidence of a species of Testudinidae in that country – viz. Hodgson's drawing.

It must be appreciated that when Gunther (1864 : 8) wrote about Hodgson's drawing, he had only seen one specimen of *T. horsfieldii*. Furthermore, *I. elongata* was described in 1853 from Burma (Blyth 1853), and the first recorded accessions in the BM (NH) of this species, all from Indo-China, were in 1861 and 1862, and at the time of Boulenger's Catalogue (1889: 174) there was still not a single specimen in the BM (NH) from a locality near to Nepal. In short, when Gunther was writing, both species were represented by very few specimens, in the BM (NH) at least, and the known range of *T. horsfieldii* was much closer to Hodgson's 'locality' than was the known range of *I. elongata*.

The resolution of which species of tortoise occurs in Nepal is of central importance to zoogeographic arguments. Well known for harbouring not only endemics, but various faunal elements from diverse zoogeographic regions and subregions (e.g. Swan and Leviton 1962), Nepal provides unique insights into the biogeographical history of these animals. One interpretation is that the Indo-Chinese tortoise has been able to expand its range westward across the Brahmaputra, along the Himalayan foothills and past the Ganges. This is consistent with the Satpura Hypothesis of Hora (1948).

However, together with the extensive north Indian/Nepalese distribution of *I. elongata*, one must consider the closely related Travancore tortoise *Indotestudo forstenii* (Schlegel and Muller), isolated some 2,000 km to the south in the Western Ghats. This situation is strong support for Smith's statement (1931 : 16): "The Indo-Chinese hill tortoises, *Testudo elongata* and *Geoemyda tricarinata*, did not extend their range into the peninsula of India (Chhota Nagpur) by crossing the Gangetic Plain" (and on p. 143: "That it [*I. elongata*] ever crossed the Gangetic Plain as we know it today is, of course, highly improbable"). Instead, these represent relict distributions of an ancestor that was widely distributed during a period when environmental conditions were very different from what they are now.

It is important to point out that Ross and Crumly (1983 : 429) misrepresented Smith (1931 : 16, 143) in stating that "Smith also contended that it was unlikely that *G. elongata* ever extended across the Gangetic Plain." Smith clearly was concerned that there are species whose present range *extends* across the Gangetic Plain, and he seemed to favour the argument that this geographic distribution predated the Gangetic Plain.

Elements of both Smith's (1931) and Hora's (1948) explanations are compatible; the two hypotheses would need to be mutually exclusive only if the time period under consideration were the same. If *I. elongata* truly is of Indo-Chinese origin, then at some point it, or its ancestor, had to expand its range westward some thousands of kilometres, across what is today Nepal and as far as Dehra Dun. This could then have been followed by a change in environmental conditions (perhaps even the birth of major rivers such as the Ganga and Brahmaputra) and subsequent isolation of the population into southern and northern hill sites.

The Nepalese and Uttar Pradesh records show that despite changes which might have taken place in the environment and distribution of *I. elongata*, it has managed to survive across the length of the Gangetic plain, nearly to the south-eastern limit of the Palearctic region. Its occurrence in both the terai and Chhota Nagpur show that it is on both sides of the Ganga, and the

species is unquestionably on both sides of the Brahmaputra.

Ironically, a complementary question which surfaces in the light of this evidence is: why has *T. horsfieldii* not be able to expand into the western Himalayan area? The eastern limit of its geographic range (Fig. 1) extends to central Afghanistan and Baluchistan (although there are questionable records from the major cities of Kabul and Islamabad). The answer appears to be in the major mountain ranges of eastern Afghanistan, northern Pakistan and Kashmir. Although the species is said to live at altitudes between 1,000 and 2,000 m (J. Anderson, pers. comm.), there is no evidence that this palearctic species has ever been able to survive – much less cross – these high ranges (over 3,000 m) with rigorous climate and impoverished soil and vegetation.

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Plate 9 of the BM (NH) collection of B.H. Hodgson's drawings. Photo courtesy British Museum (Natural History).

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APPENDIX I

LOCALITY RECORDS OF *Indotestudo elongata* AT THE WESTERN LIMIT OF ITS RANGE

1. Phandowala, Rajaji National Park, Dehra Dun Siwaliks, Uttar Pradesh, India; before 1970; coll. R.K. Bhatnagar; gravid female; probably the unnumbered mounted female in the Zoological Survey of India (ZSI), Dehra Dun.

2. Gairal Forest Rest House, Corbett National Park, 25-30 km NW of Ramnagar and about 75 km W of Nepal, Garhwal District, Uttar Pradesh, India: April 1974; Ross and Crumly 1983; photo only.

3. Sauraha, Chitwan District, Narayan, Nepal; 16 April 1985; 200 m; coll. J.C. Mitchell; USNM 267020; dog-eaten shell.

4. Sarugara Forest, '4th mile' on Siliguri - Kalimpong road, Darjeeling District, West Bengal, India; 1970's; Kumirmari in Das 1988: sight records, kept as pets.

5. Baradighi Tea Estates, Jalpaiguri District, West Bengal, India; 1915-1916; coll. W.L. Traves; seven specimens/records in ZSI: 17992 entire in spirit, 18016 entire in spirit, 18046 given to Agra College, not traced; 18124 donated to Punjab government, not traced, 18125 entire in spirit, 18162 dry shell, 18171 not seen since 1984; see also Baylis and Daubney 1922 : 303, 312 and Das 1988 : 21.

6. Gorumara, Jalpaiguri District, West Bengal, India; Subimal Roy in Das 1988 : 22; sight record.

7. Damanpur, Buxa Division, Jalpaiguri District, West Bengal, India; Subimal Roy in Das 1988 : 22; sight record.

8. Western Assam, India; locality from Hoogmoed and Crumly 1984 : Fig. 3; it is not known on what this record was based; see Das 1988 : 4.

9. Mangaldai, Darrang District, Assam, India; 1957-58; S.K. Sharma in Das 1988 : 3; sight record.

10. Tura, Garo Hills, Meghalaya, India; referred to in parasitological study of Baylis and Daubney 1922 : 304, 312.

11. West Bhanugach Reserve Forest, Moulri Bazar District, Bangladesh; 11 January 1989; Das *in litt.* 4 April 1989; shell.

12. Nainimukhi, Chittagong Hill Tracts, Bangladesh; 20 February 1922; ZSI 19239 entire in spirit.

13. Chaibasa, Chhota Nagpur, Bihar, India; Anderson 1878-9: specimen not traceable according to Annandale 1913 : 76.

14. Jasandra Singhbhum, Chaibasa, Singhbhum District, Chhota Nagpur, Bihar, India; 17 February 1901; ZSI 11379 - type of *Testudo parallelus* Annandale 1913 : 76ff.; shell etc. in spirit, dry skull.

15. Kumdi Village and Kodlibad Village, Saranda Forest, Singhbhum District, SW of Chaibasa, Bihar; 1982; Coll. E.O. Moll and J. Vijaya, EOM 2711 and 2712; Moll *in litt.* 9 Sept. 1988 & 7 Nov. 1988; two dry shells from the villages.

16. Simuli Pahar, Mayurbhanj District, Orissa; 22 February 1971; Biswas *et al.* 1978; live male in Nandankanan Zoo.

17. Puri District, Orissa; 27 April 1969; ZSI 23550; Biswas *et al.* 1978; dry shell. However, L.A.K. Singh *in litt.* 3 February 1988, states that ZSI 23550 was collected in the autumn of 1968 from near Barbara Rest House, Banapur village, Tamana or Rajin Forest Block, contiguous with Satkoshia Gorge Sanctuary (north of Mahanadi River), evidently in Cuttack dist.

Appendix II

LOCALITY RECORDS OF *Testudo horsfieldii* AT THE EASTERN LIMIT OF ITS RANGE

A. Pap Hills, Lasbela district, Baluchistan, Pakistan; PZS 40 a; entire specimen in spirit; Ghalib *et al.* 1976 : 39.

B. Kalat (Kelat), Baluchistan, Pakistan; 1906; coll. G.H. Tipper; eight ZSI specimens/records; 15537 not traceable. 15538 entire in spirit, 15539 sent to Vienna Museum, 15541 dry shell and skull, 15542 dry shell and skull,15543 dry plastron and skull ('sent to Munich Museum'), 15551 dry shell and skull and 3 eggs, 15725 eggs not traceable.

C. Kowas, Sibi District, Baluchistan, Pakistan; 5 March 1976; coll. M. Farooq Ahmed; Zoological Survey of Pakistan (PZS) 40; entire in spirit; Ghalib *et al.* 1976 : 39.

D. Quetta, Baluchistan, Pakistan; at least four specimens: BNHS 3, dry shell; ZSI 16480, skull; University of Florida 20643 and 21353, D.L. Auth *in litt.* 3 October 1988.

E. Khanai, Quetta District, Baluchistan, Pakistan: 28 April 1906; two ZSI records; 15552 dry shell and skull, 15553 sent to Munich Museum.

F. 12 miles east of Balkh, Afghanistan; BM(NH) 1940. 5.1.1; dry shell.

G?) Safed-i-Rak, Kabul, Afghanistan; ZSI 5591 to 5600 ten eggs in spirit. This locality is questionable since it is a major city, and it is likely that the specimen was a captive.

H?) Islamabad, Pakistan; MTKD (Staatliches Museum fur Tierkunde, Dresden, Germany (DDR)) N. N. This locality is questionable since it is a major city, and it is likely that the specimen was a captive.

A CATALOGUE OF THE BIRDS IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY – 35 : TROGLODYTIDAE, CINCLIDAE, PRUNELLIDAE, PARIDAE, SITTIDAE AND CERTHIIDAE

HUMAYUN ABDULALI AND SARASWATHY UNNITHAN
(Continued from Vol. 88 (1) : 80)

This part covers 866 specimens of 88 species and subspecies, nos. 1769-1851 in HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN & SYNOPSIS and 14 extra limitals. Of the 88 from Indian limits we have no specimens of 18 forms (3 species and 15 subspecies). As in Part 34, the bulk of the work has been done by S.U. and H.A. has only read over and checked the final work.

1769. **Troglodytes troglodytes magrathi** (Whitehead) (Safed Koh) Magrath's Wren. 1 : 446

nil.

1770. **Troglodytes troglodytes neglectus** Brooks (Kashmir) Kashmir Wren 1 : 446

16: 6 males (2 juv.) 4 females (2 juv.) 6 ? (2 juv.).

5 Liddar Valley, 1 Barnaibut, 2 Kashmir, 1 Tara Devi, 1 Patiala State, 1 Fagu, Keonthal State, 1 Koti State, 4 Simla, N.W. Himalayas.

There are six juveniles collected during June July and August among them whose measurements do not show much difference.

Measurements on p. 64.

1771. **Troglodytes troglodytes nipalensis** Blyth (Nepal) Nepal Wren 1 : 445

Darker than 1770 though collected in the cold weather

11 : 3 males 7 females 1 ?

1 Mangalbara, E. Nepal, 4 Phalut, Darjeeling Dt.; 3 Lachung, N. Sikkim, 2 Chimakothi, 1 Chapcha, W. Bhutan.

There are no juveniles all being collected in winter, November to February.

Measurements on p. 64.

EL. **Troglodytes troglodytes hyrcanus** (Zarudny and Loudon) Northern Iran and Turkmenia

1 ? *Dohuk, Kurdistan.*

Chin to vent washed with white, upper parts paler than in both 1770 and 1771.

1772. **Cinclus cinclus leucogaster** Bonaparte (West Siberia) Whitebellied Dipper 2:3

2: 1 male 1 female

1 *Tashkent, U.S.S.R.,* 1 *Boston Terek.*

Measurements on p. 64.

1773. **Cinclus cinclus cashmeriensis** Gould (Kashmir) Whitebreasted Dipper 2 : 2

3: 1 male 1 female 1 ?

1 Chagre, 1 Kardong, Ladak; 1 *Amuchhu; R. Phaxma, Tibet* 11000′.

Measurements on p. 64.

1774. **Cinclus cinclus przewalskii** Bianchi (Denchu, basin of the Yangtse-kiang) Eastern whitebreasted Dipper 2 : 2

nil.

1775. **Cinclus pallasii tenuirostris** Bonaparte (Himalayas) West Himalayan Brown Dipper 2 : 4

23: 14 males (6 juv.) 7 females (2 juv.) 2 ? (both juv.)

6 Chitral, 1 Banihal village, 1 Kulotran, Badrawar, 1 Kashmir; 2 Patiala State, 1 Koti State, 1 Glow stream, 1 Narkanda, 5 Simla; 1 Guptakashi, 1 Yoshinath, 2 Badrinath, Garhwal.

There are 10 juveniles (6 m, 2 f, 2 ?). Entirely different in colouration from the adult. They are grey with numerous white spots, and are smaller in measurements, which are given separately.

Measurements on p. 64.

1776. **Cinclus pallasii dorjei** Kinnear (Sakden, E. Bhutan) East Himalayan Brown Dipper 2:5

6 :1 male 4 females 1?

1 *Tibet*; 1 Kurseong, 1 *Mangdechu*, 1 *Batase, C. Bhutan, 1 Gomchu. E. Bhutan,* 1 *Mishmi Hills, Burma.*

One each from Batase (March) and Kurseong (Dec.) are paler above than the others.

Measurements on p. 64.

1777. **Prunella collaris rufilata** (Severtzov) (Turkestan) Turkestan Alpine Accentor 2 : 189

3 : 2 males 1 female

2 Kesun, 1 Drosh, Chitral.

Measurements on p. 64.

With the material available no. 1777 and 1778 are barely separable.

1778. **Prunella collaris whymperi** (Baker) (Garhwal) Garhwal Alpine Accentor 2 : 188

11 : 3 males 4 females 4 ?

2 Liddar Valley, Kashmir, 3 Kufri, Koti State, 4 Simla, N.W.H.; 2 Nila Valley, Garhwal.

Measurements on p. 64.

1779. **Prunella collaris nipalensis** (Blyth) (Kachar region of Nepal) Eastern Alpine Accentor 2 : 188

5 : 3 males 1 female 1 ? (2* missing)

1 Lachung, N. Sikkim, *1 Chapcha, W. Bhutan*, 1 Kama Valley*, 1 *E. Everest, Tibet**, 1 *Mishmi Hills.*

The two marked are missing, but the remaining three have the darkest upperparts and grey of breast.

Measurements on p. 64.

1780. **Prunella himalayana** (Blyth) (Himalaya range) Altai Accentor 2 : 191

14 : 4 males 9 females 1 ?

2 Duala-Dar range, Dharmsala, 3 Tara Devi, Patiala State, 3 Mashobra, 2 Simla N.W.H.; 4 Chungthang, Lachung, Sikkim.

Measurements on p. 65.

1781. **Prunella rubeculoides** (Moore) (Nepal) Robin Accentor 2 : 193

5 : 2 males 1 female 2 ?

1 Debring, 1 Rupshu, Kashmir, 1 Sukta, Ladak, 1 *Gyangtse, Tibet*, 1 no locality.

Measurements on p. 65.

1782. **Prunella strophiata jerdoni** (Brooks) (Kashmir) Western Rufousbreasted Accentor 2 : 197

16 : 4 males 7 female 5 ?

1 Gulmarg, 1 Mornaula, 1 Pyas, Kishtwar, 3 Liddar Valley, 1 Kashmir; 1 Fagu, Keonthal St., 2 Koti State, 2 Patiala State, 3 Simla N.W.H.; 1 Pindari, Garhwal.

3 (sex?) immature from Liddar (2) and Pindari (Garhwal) differ in the absence of the broad band across the breast, the orange-rufous eyebrow and the faint trace of the double wing-bar. The last in white exists in the one from Pindari 10500′, and the bird has a paler breast band and pale eyebrows.

Measurements on p. 65.

1783. **Prunella strophiata strophiata** (Blyth) (Nepal) Eastern Rufousbreasted Accentor 2 : 196

18 : 7 males 3 females 8 ?

2 Lachung, N. Sikkim, 1 Sikkim, 1 Native Sikkim; *1 Honka, 2 Chimakoti, 1 Chapcha, W. Bhutan, 1 Shamgong, 1 Batase, C. Bhutan, 5 Rongtong, 1 Wamrong, 1 Gomchu, 1 Narphong, E. Bhutan.*

Measurements on p. 65.

1784. **Prunella fulvescens fulvescens** (Severtzov) (Turkestan) Turkestan Brown Accentor 2 : 198

5: 1 male 2 females 2 ?

1 Chitral, Drosh, 1 Gilgit, 1 Kashgar, Vibulak, 1 Kardong, 1 Sasar Pass, Ladak.

Measurements on p. 65.

1785. **Prunella fulvescens sushkini** Collin & Hartert (Khamba-jong, Tibet) Tibet Brown Accentor 2 : 198

1 male *Kaungmar; Tibet.*

Measurements on p. 65

1785a. **Prunella fulvescens ocularis** (Radde) (Kiz Yurdi Mt, Talych) Radde's Accentor 8 : 626

1 (sex?) Chaman, Baluchistan.

1786. **Prunella atrogularis huttoni** (Moore) (Simla) Turkestan Blackthroated Accentor 2 : 194

11: 4 males 4 females 3 ?

1 Quetta, 1 Wana, Waziristan, 2 Drosh, 1 Ayun, 2 Chitral, 1 Gora Gali, Murree Hills, 1 Rawalpindi; 1 Patiala St., N.W.H.; 1 Chandigarh, Ambala Dt.

Measurements on p. 65.

1787. **Prunella atrogularis atrogularis** (Brandt) (Semipalatinsk) Ural Blackthroated Accentor 2 : 194

nil.

1787a. **Prunella montanella montanella** (Pallas) (Dauria) Siberian Accentor

nil.

1788. **Prunella immaculata** (Hodgson) (Central and northern regions of the Hills, Nepal) Maroonbacked Accentor 2 : 193

6: 1 male 2 females 3 ?

1 Shamgong, C. Bhutan, 3 Gomchu, 1 Narphong, E. Bhutan, 1 North Shan States, Burma.

Measurements on p. 65.

1789. **Melanochlora sultanea sultanea** (Hodgson) (Central and northern regions of the Hills, Nepal) Sultan Tit. 1 : 101

28 : 17 males 11 females

1 Nepal, 2 Longview TE, 2 Savoke, Darjeeling Dt., 2 Pershoke, Sikkim, 1 Martham, Rongni Valley, *2 Tama, C. Bhutan, 2 Deothang E. Bhutan,* 1 Singtam, Teesta Valley, 1 Hungrum, N. Cachar, 1 Bagh-o-bahar, Cachar, 2 Margherita, 2 Tezu, Lohit Valley, U. Assam; 1 Tarajuli, Arunachal Pradesh, 1 *Memon, U. Burma,* 1 *SE of Maymyo,* 1 *Mansum,* 1 *Dabahka,* 3 *Tangti, North Shan States, Burma,* 1 no locality.

Measurements on p. 65.

1790. **Parus major ziaratensis** Whistler (Ziarat, Baluchistan) Baluchistan Grey Tit 1 : 76

1 female, Harboi, Baluchistan.

Measurements on p. 66.

1791. **Parus major decolorans** Koelz (Jalabad, eastern Afghanistan) Afghanistan Grey Tit 1:76

nil.

1792. **Parus major caschmirensis** Hartert (Gilgit) Kashmir Grey Tit 1: 76

14 : 6 males 5 females 3 ?

3 Chitral, N.W.F.P.; 1 Dachigam, 1 Badat, Kishtwar, 1 Kashmir, 1 Jhelum, 1 Jhalor, nr. Campbellpur, 1 Lahore, 1 Ambala, Punjab, 1 Bhajji St., 3 Simla, N.W.H.

A high altitude bird, descends to lower elevations in winter.

Measurements on p. 66.

1793. **Parus major nipalensis** Hodgson (Nepal) Nepal Grey Tit 1 : 74, 77

10 : 6 males 3 females 1 ?

1 Bhajji State, 1 Gama-ki-Hatti, Dharmi State, 1 Kalka, 3 Simla N.W.H., 1 Karuprayag, 1 Ranighet, 1 Almora, Garhwal, 1 Pilibhit Terai, U.P.

Averages smaller than *caschmirensis.*

Measurements on p. 66.

1794. **Parus major stupae** Koelz (Sanchi, Bhopal) Indian Grey Tit 1 : 77

41: 19 males 12 females 10 ?

3 Sunda Hill, Jaswantpura, Dt. Jodhpur, 1 Narwar Fort, Gwalior State, 1 Gangasagar, Palanpur St., Gujarat, 2 Jambughoda, 2 Dohad, Panch Mahals, 1 Dalkhania, Amreli Dt., Kathiawar, 1 Ghatwad, S. Kathiawar, 1 Malegaon, 1 Laochali, Surat Dangs, 2 Bijwar, Indore St., 1 Jabalpore, C.I., 1 Bhanupratappur, Kanker, 2 Konta, Bastar Dt., C.P., 1 Nasik, 1 Suriamal, Thane Dt., 1 Mehda, 1 Satara, 2 Dodballapur, Bangalore, 1 Kumili, 1 Merchiston, Ponmudi, S. Travancore, 1 Kotagiri, Nilgiris, 1 Manalur, Palni Hills, 2 Nelipaka, 1 Kaulas, 1 Paloncha, Hyderabad, 1 Kutri, Daspalla, 3 Badrama, Bamra, 1 Chahala, Simlipal, Orissa, 3 Rajapati, Chapra, Saran Dt., Bihar.

Measurements on p. 66.

1795. **Parus major mahrattarum** Hartert (Ceylon) Ceylon Grey Tit 1 : 77

nil.

1796. **Parus major vauriei** Ripley (Chabua, Northeastern Assam) Lakhimpur Grey Tit 1 : 74

4 : 3 males 1 female

3 Dibrugarh, 1 Sadiya, U. Assam.

Measurements on p. 66.

1797. **Parus major tibetanus** Hartert (Chaksam in Tsangpo Valley, Tibet) Tibet Grey Tit 1 : 346

nil.

EL. **Parus major commixtus** (Swinhoe) (South China) Burmese Great Tit 1 : 78

4 : 1 male 1 female 2 ?

1 *U. Burma,* 1 *Maymyo,* 1 *Saw pakoku,* 1 *Shatzusth, North Shan States, Burma.*

Measurements on p. 66.

EL. **Parus major minor** Temminck & Schlegel (Japan)

2 males

1 *Forgyi, Shan States, Burma,* 1 *Peking, China.*

Measurements on p. 66.

EL. **Parus major major** Linnaeus (Sweden)

1 male, *Hungary* ?

Measurements on p. 66.

EL. **Parus major intermedius** Zarudnyi (Kopet Dagh mountain system of Afghanistan & Baluchistan)

7 : 4 males, 3 females

1 *Shiraz,* 1 *Turbat,* nr *Meshed,* 5 *Meshed, Persia.*

Measurements on p. 66.

EL. **Parus major blanfordi** Prazak (Tehran)

6 : 2 males 2 females 2 ?

1 *Dohuk, Kurdistan,* 1 *Shush, Karkheh River,* 1 *Jungle on Karkheh R.,* 1 *Legation-Gulahek, Tehran,* 1 *Shiraz,* 1 *Engeli, Persia.*

Measurements on p. 66.

1798. **Parus nuchalis** Jerdon (Eastern Ghats) Whitewinged Black Tit 1 : 79

11: 7 males 3 females 1 ?

1 Gangasagar, Palanpur, 4 Bhuj, 2 Mata-no-madh, 2 Chaduva, 1 Godsar, Bhuj env., 1 Kutch.

Baker (Fauna Vol. 1, p. 79) gives one description of the bird, so we presume he intended this for both the sexes. Indian Handbook (Vol. 9, p. 172) says the sexes are alike. Mr Simon Harrap who has been working on the Paridae at the British Museum drew our attention to the following in his mss. He has examined the material at the B.M. and says the sexes are distinct in so far as the male has the entire upper parts deep black, glossed blue, strongest on the crown and mantle. The female has the upper parts duller, sooty brown-black glossed blue on the crown only, flanks and sides of breast with a more distinct pale yellow wash than in the male, the median line on the underparts very slightly paler. In general our observations agree with this.

In the three female specimens the crown is sooty brown-black without a blue gloss and flanks and sides of breast without any pale yellow wash, (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN says this colour fades into pure white in museum specimens) and the median line is definitely paler than in the male. Of the two males from Kutch, one collected on 28 Sept. 1943 and the other going back to July 1896, both lack the glossy black of the other males; the former is either wrongly sexed or is in juvenile plumage while the latter may have faded. The unsexed specimen from Gangasagar is in male plumage.

Perhaps the publication of the Harrap notes may produce additional information from other sources.

Measurements on p. 66.

1799. **Parus monticolus monticolus** Vigors (Himalayan Mountains = Simla) Greenbacked Tit 1: 80

43 : 23 males 13 females 7 ?

1 Dachigam, Kashmir, 2 Dalhousie, Punjab, 12 Simla, N.W.H., 1 Mussoorie, 1 Bora, Almora, 1 Ghat, 1 Pothibassa, 1 Yoshinath, Garhwal, 1 Himalayas, 1 Godavri, Nepal, 1 Kurseong, 4 Rinchinpong, W. Sikkim, 1 Sikkim, *1 Chimakothi, W. Bhutan, 1 Khosela, 1 Narphong 1 Wamrong, E. Bhutan*, 5 Shillong, 2 Kohima, Naga Hills; 1 *Dam*, 1 *Lac-Tango, S. Tibet*, 1 *Chin Hills*, 1 *Loi Wong, N. Shan States, Burma.*

Measurements on p. 66.

1800. **Parus cyanus flavipectus** Severtzov (Turkestan) Yellowbreasted Blue Tit

2 : 1 male 1 female

2 Chitral. No yellow is visible on the breast.

Measurements on p. 67.

1800a. **Parus cyanus tianschanicus** (Menzbier) (Tien Shan) Tien Shan Blue Tit 1 : 81

nil.

1801. **Parus hypermelas** (Berezovski & Bianchi) (Shensi and the border of Kansu) Blackbibbed Tit 1 : 82

nil.

1802. **Parus melanolophus** Vigors (Himalayan Mountains= Simla-Almora area) Crested Black Tit 1 : 83

28 : 17 males 6 females 5 ?

2 Chitral, 1 Nultar Valley, Gilgit, 2 Liddar Valley, 1 Kashmir, 1 Rawalpindi, 2 Dalhousie, Punjab, 3 Simla, 1 Fagu, Keonthal St., 1 Mt. Hutto, Kumarsain, 2 Kufri, 1 Koti St., 4 Dakuri, Kumaon, 1 Dungari, 1 Mounkhal, 1 Talla, Garhwal, 1 Sirkunda 4 m from Dhanaulti, Mussoorie, 1 Bhawali, Nainital; 2 no locality.

Measurements on p. 67.

1803. **Parus ater aemodius** Hodgson (Nepal) Himalayan Coal Tit 1: 84

6: 3 males 3 females

5 Lachung, N. Sikkim, *1 Bumthang, C. Bhutan.*

Measurements on p. 67.

1804. **Parus rubidiventris rufonuchalis** Blyth (range beyond Simla) Simla Black Tit 1 : 85

20: 10 males 9 females 1?

2 *Tashkent, U.S.S.R.*, 4 Rawalpindi, 4 Chitral, 1 Srinagar, 1 Liddar Valley, 2 7 m below Yus, 1 Danguil, Kishtwar, Kashmir, 1 Kaying Bashi, 2 Baghi, Bushahr St., N.W.H., 1 Harsi, 1 Gangotri, Garhwal.

Measurements on p. 67.

1805. **Parus rubidiventris rubidiventris** Blyth (Nepal and Sikkim, restricted to Kathmandu Valley by Ripley) Rufousbellied Crested Tit 1 : 84

1 male, Kalabagh, Jubbal St., Garhwal.

Rufous abdomen separates this subspecies from others.

Measurements on p. 67.

1806. **Parus rubidiventris beavani** (Jerdon) (Mount Tonglo, Sikkim) Sikkim Black Tit 1 : 86

3 males

1 Tonglo, 2 Phalut, Darjeeling.

Measurements on p. 67.

1806a. **Parus rubidiventris saramatii** Ripley. (Mount Saramati, Naga Hills) Nagaland Black Tit.

nil.

1807. **Parus dichrous kangrae** (Whistler) Koti State, near Simla) Western Brown Crested Tit 1 : 87

4: 1 male 2 females 1 ?

2 Narkanda, 1 Baghi, Bushahr State, 1 Simla Hills, N.W.H.

Measurements on p. 67.

1808. **Parus dichrous dichrous** Hodgson (Nepal) Eastern Brown Crested Tit 1 : 87

3: 2 males 1 female

1 Lachung, N. Sikkim, 2 Tongloo, near Darjeeling.

Measurements on p. 67.

1809. **Parus xanthogenys xanthogenys** Vigors (Himalayan Mountains restricted to Murree by Baker) Northern Yellowcheeked Tit

18 : 11 males 3 females 4?

1 Ghora gali, Murree Hills, 2 Dalhousie, Punjab; 2 Keonthal State, 6 Simla, N.W.H., 1 Bhim Tal, 1 Ranibaug, 1 Mornaula, 1 Bhawali, 1 Naini Tal, 1 Kumaon, 1 Godavri, Nepal.

Measurements on p. 67-68.

1810. **Parus xanthogenys aplonotus** Blyth (Mountains of central India, restricted to Chaibasa, Singhbhum, Bihar by Whistler and Kinnear) Central India Yellowcheeked Tit 1 : 92

33: 17 males 13 females 3 ? (1 male 2 females by plumage).

3 Juna, Rajpipla, 1 Pandwa, 1 Malegaon, Surat Dangs, 1 Lonawala, Western Ghats, 1 Poona, 2 guna, 1 Badarwas, Gwalior State, 1 Saugar, 1 Sehore, Bhopal State, 1 Paryat, Jabalpur, 1 Mandu, Dhar State, 1 Melghat, Raipur, Berar, 1 Lahottar Reserve Forest, 2 Bhanupratappur, Kanker, 1 Darba, Bastar Dt. 1 Upper Bharakhamba, 1 Chahala, Simlipal, 3 Badrama, Bamra, Orissa, 5 Anantgiri, 1 Valaspara, near Sileru, 1 Sankrametta, Vizagapatnam, 2 Wangasara, Andhra Pradesh.

Measurements on pp. 67-68.

1811. **Parus xanthogenys travancoreensis** (Whistler & Kinnear) (Mynall, Travancore) Southern Yellowcheeked Tit 1 : 92

23: 17 males 5 females 1?

1 Colvalli, Goa, 1 South Konkan, 2 Sunkal, 2 Castle Rock, Kanara, 1 Horabail, Sagar, Shimoga, 1 Jagar Valley, Bababudan Hills, Kadur Dt., 1 Sakleshpur, Hassan Dt., Mysore, 2 Mercara, Coorg, 1 Runnimadi, 1 Kottamalai, Cherambadi, 1 Kodanad, beyond Kotagiri, Nilgiris, 1 Perumalmalai, 6 Shembagnur, Palni Hills, 2 Santanpara, Cardamom Hills.

There is no polymorphism as stated by Whistler and Kinnear in the description (Unnithan *infra* p. 126).

Measurements on p. 68.

1812. **Parus spilonotus spilonotus** Bonaparte (Himalaya, restricted to N. Cachar by Baker) Himalayan Blackspotted Yellow Tit 1 : 89

15: 8 males 6 females 1 ?

1 Sikkim, 1 Darjeeling; *1 Tama, C. Bhutan, 2 Wamrong, E. Bhutan*, 2 Barha Pari, 7 Shillong, 1 Cherra, Assam.

All these specimens were wrongly identified and registered as *Parus xanthogenys.*

Measurements on p. 68.

1812a. **Parus spilonotus subviridis** Blyth (Tenasserim) Burmese Blackspotted Yellow Tit. 1: 91

1 (sex?) *Pimpri Ban, S. Shan States, Burma.*

This was also in the *Parus xanthogenys.*

EL. **Parus palustris hellmayri** Bianchi (Peking).

4: 2 males 2 females

4 *Temple of Heaven, Peking.*

These were in *P. major.*

Measurements on p. 68.

1813. **Sylviparus modestus simlaensis** Baker (Simla) Simla Yellowbrowed Tit 1:88

7: 4 males 3 females

3 Dharmsala, 4 Simla, N.W.H.

The yellow has almost disappeared from the forehead.

Measurements on p. 68.

1814. **Sylviparus modestus modestus** Burton (Nepal) Eastern Yellowbrowed Tit 1 : 88

11: 5 males 4 females 2 ?

1 Mangalbare, E. Nepal, 1 Chungthang, N. Sikkim, *1 Chapcha, West, 2 Chimakothi, West, 1 Shamgong, Central, 3* Gomchu, 2 Rongtong, East Bhutan.

Measurements on p. 68.

1815. Cephalopyrus flammiceps flammiceps (Burton) (Mussoorie) Western Firecapped Tit 2 : 545

9: 5 males 4 females

1 Kalka, 4 Simla, N.W.H., 1 Ladwa, Karnal Dt., 2 Baretha, Bharatpur, 1 Surwaya, Gwalior.

Measurements on p. 68.

1816. Cephalopyrus flammiceps olivaceus Rothschild (Vicinity of Tengyueh) Eastern Firecapped Tit. 1 :545

3 males

2 Gomchu, E. Bhutan, 1 Goalpara, Assam.

Measurements on p. 68.

1817. Remiz pendulinus coronatus (Severtzov) (Khodzhent, Turkestan) Penduline Tit 1 : 100

10: 3 males 7 females

1 Karram Darra, Persia; 2 Kohat, N.W.F.P., 2 Lahore, Punjab, 1 Bahawalnagar, 2 Harunabad, 2 Bahawalpur town env.

Measurements on p. 68.

1818. Aegithalos concinnus iredalei (Baker) (Himalayas restricted to Simla) Western Redheaded Tit 1 : 93

32: 16 males (3 juv.) 7 females (juv.) 9 ? (5 juv.)

1 Mugalmaidan, 2 Bandarkoti, Kishtwar, 3 Dalhousie, 1 Dharmsala, Punjab, 2 Dakuri, 10 Simla, 3 Koti St., 2 Kufri, Patiala St., N.W.H., 1 Pindari Valley, 2 Loliba, 2 Mussooree, 1 Mornaula, U.P., *1 Godavri, 1 Sheopur Ridge, Nepal.*

Juveniles of both sexes have pale forehead and underparts.

Measurements on p. 69.

1819. Aegithalos concinnus rubricapillus (Ticehurst) (Sikkim) Eastern Redheaded Tit 1 : 93

8: 5 males 2 females 1?

1 Chungthang, 1 Rinchinpong, W. Sikkim; *1 Gedu, West, 1 Batase, 1 Shamgong, Central, 1 Wamrong, 1 Gomchu, 1 Rongtong, East Bhutan.*

Upperparts darker and underparts more rufous than in 1818.

Measurements on p. 69.

1820. Aegithalos concinnus manipurensis (Hume) (Eastern hills, Manipur) Manipur Redheaded Tit 1 : 94

1 ? *Chin Hills, Burma.*

EL. Aegithalos concinnus pulchellus (Rippon) (Nanoi, S. Shan States) Shan Redheaded Tit 1 : 95

1 *? South Shan States, Burma.*

1821. Aegithalos leucogenys (Moore) (Balu Chughur, north east Afghanistan) Whitecheeked Tit 1 : 97

5: 3 males, 2 females

3 Chitral, 2 Jhalor near Campbellpur, W. Punjab.

All the five are correctly marked *leucogenys* by earlier workers.

Measurements on p. 69.

1822. Aegithalos niveogularis (Gould) (North India restricted to northern Punjab) Whitethroated Tit 1 : 98

nil.

1823. Aegithalos iouschistos iouschistos (Hodgson) (Nepal) Rufousfronted Tit 1 : 99

4 males

1 Darjeeling, 2 Chapcha, West, 1 Rongtong, East Bhutan.

Measurements on p. 69.

EL. Aegithalos bonvaloti sharpei (Rippon) (Mt. Victoria, Chin Hills) Mt. Victoria Blackheaded Tit 1 : 97

1 ? *Mt. Victoria, Chin Hills.*

1824. Sitta europaea cashmirensis Brooks (Kashmir) Kashmir Nuthatch 1 : 128

5 : 1 male 3 females 1 ?

1 Shinghar, North East Baluchistan, 2 Chitral, NWFP, 1 below Pahalgam, 1 Kashmir.

Measurements on p. 69.

1825. Sitta europaea montium La Touche (Atuntze, N.W. Yunnan) Chinese Nuthatch

nil.

1826. Sitta europaea nagaensis Godwin-Austen (Naga Hills) Naga Nuthatch 1 : 127

2 ? 1 *Mt. Victoria,* 1 *Keelpkai, South Shan States, Burma.*

1827. Sitta castanea almorae Kinnear & Whistler (Valley of Ramganga between Almora and Pethora) 1 : 125

7: 4 males 2 females 1 ?

3 Ranibaug, Kumaon, 1 Gwaldam, Garhwal, 1 Bans, 1

Gurua, 1 Bageswar, Almora, U.P.

Measurements on p. 69.

1828. Sitta castanea cinnamoventris Blyth (Darjeeling) Eastern Chestnutbellied Nuthatch 1 : 125

17: 11 males 5 females 1 ?

1 Singtam, Teesta Valley, 1 Martam, Rongini Valley, 1 Rangpo, Sikkim, 1 Samchi, West, 2 Tama, 1 Mangdechu, Central, 1 Deothang, East Bhutan, 1 Shillong, 4 Margherita, 1 Tezu, Lohit Valley, 1 Mishing, Abor Country, 2 40 miles from Miao, Arunachal Pradesh.

Measurements on p. 69.

1829. Sitta castanea koelzi Vaurie (Patkai Hills, Assam-Burma Border) Naga Chestnutbellied Nuthatch 1 : 125

nil.

1830. Sitta castanea castanea Lesson (Bengale) Peninsular Chestnutbellied Nuthatch 1 : 123

22: 13 males 9 females

3 Ambala, 1 Indri, Karnal Dt., 1 Dehradun, 1 Kumaon, Nainital, 1 Meerut, 2 Chikalda, 1 Raipur, Melghat, Berar, 2 Kaulas, Nander Dt., 1 Antagarh, 1 Bastar St., 4 Bhanupratappur, Kanker, C.P., 1 Banaras, 2 Baghowni, Tirhut, 1 Narhar, Madhubani.

Measurements on p. 69-70.

1831. Sitta castanea prateri Whistler & Kinnear (Anantagiri, Vishakhapatnam Dt.) Eastern Ghats Chestnutbellied Nuthatch 1 : 123

11 : 6 males 5 females

3 Koira, Bonai, 2 Chahala, 2 Gurguria, Simlipal hills, Mayurbhanj, Orissa, 3 Anantagiri, 1 Sankrametta, Vishakhapatnam Dt.

This race is separable from the nominate by their heavier bill and larger size. But Vaurie 1957 (Palearctic birds No. 29, p. 19) opines that *prateri* does not appear to be separable from *castania* and synonymises it with the nominate race.

Measurements on p. 69-70.

EL. Sitta castanea neglecta (Wald, A.M.N.H.) (Karen Hills) Burmese Nuthatch

4 : 1 male 1 female 2 ?

1 *Maymyo, Mandale Dt.*, 1 *Loikaw, South Shan States*, 1 *Imbin,. Henzada Dt.*, 1 *Jonge, Burma.*

Measurements on p. 69-70.

1832. Sitta leucopsis leucopsis Gould (Himalayas) Western Whitecheeked Nuthatch 1 : 130

10: 3 male 5 females 2 ?

1 *Kafiristan*, 1200′ *Afghanistan*; 1 Dungagali, 1 Bodiar, 1 Chitral, N.W.F.P.; 1 Kufri, 2 Koti St., 1 Simla N.W.H.; 1 Garhwal; 1 no locality.

Measurements on p. 70.

1833. Sitta leucopsis przewalskii Berezovski & Bianchi (Mindsheu dist., Upper Hwangho R., eastern Tsinghai, China) Eastern Whitefaced Nuthatch

nil.

1834. Sitta himalayensis himalayensis Jardine & Selby (Himalaya Mts = Simla) Himalayan Whitetailed Nuthatch 1 : 122

a) 16: 7 males 7 females 2 ?

3 Dakuri, 8900′, 2 Koti State, 7 Simla, N.W.H.; 2 Mussorie, 1 Gorikund, Kedarnath, 1 Garhwal, U.P.

Measurements on p. 70.

b) 16: 8 males 8 females

2 Hathiban, Nepal, 2 Chungthang, N. Sikkim, 1 Darjeeling, 1 Gedu, W., 1 Batase, C., 1 Shamgong, Central, 1 Narphong, 3 Wamrong, 3 Gomchu, 1 Rongtong, East Bhutan.

Eastern birds could be separated from the Western Himalayan birds by paler throat and breast and in measurements they average smaller, and are separately marked and kept.

Measurements on p. 70

1835. Sitta himalayensis australis Koelz (Tekhubama, Naga Hills, Assam) Assam Whitetailed Nuthatch 1 : 122

nil.

1836. Sitta tephronota tephronota Sharpe (Kokand, Ferghana, Central Asia) Eastern Rock Nuthatch 1 : 129

11 : 4 males 5 females 2 ?

1 *Najimabad, Korasan*, 4 *Amirabad*, 1 *Rum 52 m N. Birjand*, 1 *Meshed*, 1 *Naugab, nr. Kain, Persia;* 1 Srinagar, 1 Quetta, 1 Mazhmonk stream 11 m E of Kalat.

All the eleven specimens are marked *Sitta neumayer tephronota* by earlier workers.

Measurements on p. 70.

EL. Sitta tephronota dresseri Zar & But (Mountains of S.W. Persia)

13: 3 males 8 females 2 ?

1 *Kasu, Sheser*, 1 *Shustan, Persia*, 11 *Persian Gulf.*

Paler and larger than *tephronota*. The bill is much longer and heavier. All of them are marked

Sitta neumayer dresseri by earlier workers. Three specimens 662 f, 663 f and 664 (sex?) are greyer below instead of the usual white fawn colour, are marked by C.B. Ticehurst as "*dresseri* but very dirty".

Measurements on p. 70.

1837. **Sitta formosa** Blyth (Darjeeling) Beautiful Nuthatch 1 : 131

nil.

1838. **Sitta frontalis frontalis** Swainson (Ceylon) Velvetfronted Nuthatch 1 : 132

51: 21 males 21 females 9?

1 Dehra Dun, 1 Bans, Almora, 2 Ranibaug, U.P., 2 Songadh, Navsari Dt., Gujarat, 1 Antagarh, 1 Bailadila, Basatar Dt., 1 Molem, Goa, 2 Kadra, N. Kanara, 2 Honamethi estate, Mysore, 1 Palakapandy, S. Malabar, 1 Muthukuzhi, 1 Kumili High Range, 1 Peerumedu, 1 Devikulam, Travancore, 1 Shembagnur, 1 Palnighat, 1 Longwood Shola, 3 Ootacamund, 2 Avalanche, Nilgiris, 1 Shevaroy Hills, Salem Dt., 1 Dharakonda, 1 Anantagiri, 2 Sankrametta, Vizag, 1 Koira, Bonai, 1 Badrama, Bamra, 2 Chahala, Simlipal, Mayurbhanj, Orissa, 1 Bagho-o-bahar T.E., Cachar, 2 Rama T.E., S. Sylhet, 1 Singtam, Teesta Valley, 1 Sukua, Darjeeling Dt., 3 Barhapani, 1 Shillong, Assam; 3 *Sima, U. Burma,* 1 *Jade-mines,* 1 *Mindon Yoma, Thayetmyo,* 2 *Henzada, Burma.*

Measurements on p. 70.

1839. **Tichodroma muraria nepalensis** Bonaparte (Central Asia) Wall Creeper 1 : 441

26: 10 males 10 females 6 ?

1 Quetta, Baluchistan, 1 Rawalpindi, 1 Madhopur, Gurdaspur Dt., 1 Rajapur, Kangra Dt., 1 Jagadri, Ambala Dt., Punjab, 1 Tara Devi, 1 Keonthal St., 3 Simla, N.W.H., 1 Garhwal, 1 Dehradun, 1 Bhim Tal, 1 Kumaon, U.P., 1 Chungthang, Sikkim, 3 Kurseong Div., 2 Long View T.E., Darjeeling Dt., 1 Khosela, 1 Chapcha, W. Bhutan, 1 Narphong, E., 2 Gomchu , E. Bhutan, 1 Kangmar ?

There is much variation in the extent of grey on the upper parts but this cannot be linked with any other factors.

Measurements on p. 70.

EL. **Tichodroma muraria muraria** (Linn.) (Southern Europe)

2 : 1 male 1 ?

1 *Birjand,* 1 *Nineveh, Persia.*

Measurements on p. 70.

1840. **Salpornis spilonotus rajputanae** R. & A. Meinertzhagen (Sambhur) Rajasthan Spotted Grey Creeper 1 : 439

1 male Nazirabad, Rajputana.

Upper parts greyer than in the nominate subspecies and under parts not heavily marked.

This specimen is marked *rajputanae* by Meinertzhagen. It does appear paler than the nominate form.

Measurements on p. 71.

1841. **Salpornis spilonotus spilonotus** (Franklin) (Vindhyan Hills) Indian Spotted Grey Creeper 1 : 439

5: 2 males 1 female 2 ?

2 Dediapada, Rajpipla St., Gujarat, 1 Kannad, Aurangabad Dt., 1 Bhanupratappur, Kanker, C.P.; 1 no locality.

Upperparts darker and underparts more heavily marked than *rajputanae.* The female has been misplaced and cannot now be found.

Measurements on p. 71.

1842. **Certhia familiaris hodgsoni** Brooks (Cashmir) Kashmir Tree Creeper 1 : 434

nil.

1843. **Certhia familiaris mandelli** Brooks (Sikkim) Mandelli's Tree Creeper

5: 1 male 3 females 1 ?

1 Yoshimath, Garhwal, 2 Lachung, N. Sikkim, 1 Chapcha, West, 1 Tama, Central Bhutan.

Measurements on p. 71.

1844. **Certhia familiaris khamensis** Bianchi (Kansu .... Upper Mekong = Kham, upper Mekong) Tibetan Tree Creeper 1 : 434

nil.

EL. **Certhia familiaris bianchii** Hartert (Northern China-Kansu)

2 females, one from Temple of Heaven and another from Peking.

bianchii is less whitish below and has a slightly longer bill, much darker.

Measurements on p. 71.

1845. **Certhia himalayana limes** Meinertzhagen (Gilgit) West Himalayan Tree Creeper 1 : 430, 431

10 : 2 males 6 females 2 ?

1 Yusmarg Fir Forest, 1 Chinchoti, Kishtwar, 1 Kashmir, 1 Jammu State nr Madhopur, 2 Dalhousie, 1 Chachran, 1 Bhung, 1 Bahawal nagar, 1 Bahawalpur town env., Punjab.

Measurements on p. 71.

1846. **Certhia himalayana taeniura** Severtzov (Chimkent, Turkestan) Turkestan Tree Creeper 1 : 431

3: 1 male 1 female 1 ?

Three specimens from Rawalpindi, Punjab are marked by Salim Ali as *taeniura* (or *limes*). They are palest and greyish above and appear to be different from *limes*.

Measurements on p. 71

1847. **Certhia himalayana himalayana** Vigors (Himalayan Mountains) Himalayan Tree Creeper 1 : 430

17: 8 males 3 females 6 ?

2 Liddar Valley, Kashmir, 1 Baghi, Bushahr State, 1 Mahasu, 1 Koti State, 1 Kalka, Bhagat State, 8 Simla, N.W.H., 1 Chandigarh, Ambala, 1 Mouna Khel, Garhwal; 1 no locality.

All specimens are correctly marked by Salim Ali as *himalayana*.

Measurements on p. 71.

1848. **Certhia himalayana infima** Ripley (Tikapur, Kilali Dt., Western Nepal) West Nepal Tree Creeper 1 : 430

nil.

1849. **Certhia discolor discolor** Blyth (Darjeeling) Sikkim Tree Creeper 1 : 435

23: 16 males 4 females 3 ?

1 Godavri, Nepal, 1 Kurseong, Darjeeling Dt., 2 Temi, 3 Rinchinpong, W. Sikkim, 1 Khosela, 3 Gedu, 1 Honka, West Bhutan, 1 Batase, 2 Tama, 1 Shamgong, 1 Mangdechu, Central Bhutan, 3 Wamrong, 3 Gomchu, East Bhutan.

Mesurements on p. 71.

1850. **Certhia discolor manipurensis** Hume (Eastern Hills, Manipur) Manipur Tree Creeper 1:437

1 ? *Chin Hills, Burma.*

Darker and less fulvous above than the nominate race.

1851. **Certhia nipalensis** Blyth (Nepal) Nepal Tree Creeper 1:438

2 : 1 female 1 ?

1 Chimakothi, 1 Honka, West Bhutan.

Measurements on p. 71.

EL. **Certhia brachydactyla brachydactyla** (Brehm) (Road valley, Thuringia, Germany)

1 unsexed specimen from *Budakeni, Hungary* marked *C.b. brachydactyla* Brehm, by the collector.

	Wing	Bill	Tarsus	Tail
		1770-71 Troglodytes troglodytes subspp.		
Male				
1770 *neglectus* (6)	43-48 av. 46.8	9.4-12.1 av. 10.8	15.6-19 av. 17.2	25-31 av. 28.2
	(Baker MF 47-51	*c.*11	19-20	26-30)
1771 *nipalensis* (3)	47.5, 50, 51	11.2, 11.5, 13	15.5, 16.6, 21.3	35, 35, 36
	(IH 50-59	from skull 13-15	19-20	30-33)
Female				
neglectus (4)	45-49 av. 47.2	9.5-10.5 av. 10	16.9-17.5 av. 17.1	27-30 av. 28.5
nipalensis (7)	45-53 av. 48.2	11.3-13 av. 12	15.4-20 av. 17.04	25-34 av. 30.1
	(IH 47-53	from skull 13-14	19-20	27-31)
		1772-73 Cinclus cinclus subspp.		
Male				
1772 *leucogaster* (1)	87	18.4	27	52
	(Dementiev 80-95)			
1773 *cashmeriensis* (1)	102	–	26	55
	(Baker MF 90-100	–	27-29	48-56)
Female				
leucogaster (1)	88	20	28	48
	(Dementiev 79-94)			
cashmeriensis (1)	96	18.5	22	54
		1775-76 Cinclus pallasii subspp.		
Male				
1775 *tenuirostris* (adult)(8)	96-102 av. 98.1	17.9-20.1 av. 19.3	28.8-30.5 av. 29.6	50-55 av. 53.8
tenuirostris (juveniles) (6)	82-100 av. 93.8	14.2-19.8 av. 17.7	28-30 av. 28.9	42-52 av. 48.3
	(IH 95-100	from skull 24-25	30	57-60)
1776 *dorjei* (1)	100	19.5	29	47
	(IH 98-111	from skull 22-26	30-33	45-54)
Female				
tenuirostris (adult) (5)	89-103 av. 97.6	18-20 av. 19.5	28-32 av. 30.1	49-56 av. 52.2
tenuirostris (juveniles) (2)	91,100	18.4, 20.5	27.6, 29	47, 50
	(IH 91-94	from skull 24	27-29	50-55)
dorjei (4)	90-105 av. 94.5	20.5-22	26-31	46-51
	(IH 90-101	from skull 22-26	30-33	45-54)
		1777-79 Prunella collaris subspp.		
Male				
1777 *rufilata* (2)	95, 98	12, 14.5	24, 24.5	57, 65
	(IH 95-105	from skull *c.* 17	*c.* 24	68-71)
1778 *whymperi* (3)	88, 97, 99	11.6, 12.7, 13.8	21.2, 22.5	50, 56, 58
	(IH 93-102	from skull 15-16	–	62-70)
1779 *nipalensis* (1)	90	12.2	19.7	58
	(IH 96-105	from skull 15-16	*c.* 25	63-69)
Female				
rufilata (1)	88	14	23	57
	(IH 89-102	from skull *c.* 17	*c.* 24	68-71)
whymperi (4)	90-92 av. 91	13.1-13.7 av. 13.3	22-23.8 av. 22.8	55-61 av. 57.2
	(IH 91-94	from skull 15-16	–	56-63)

	Wing	Bill	Tarsus	Tail
		1780 Prunella himalayana		
Male (4)	89-100 av. 93.2	11.2-12.5 av. 11.9	21.7-23.7 av. 22.6	49-60 av. 54.7
	(IH 89-99	from skull 14-15	22-26	54-62)
Female (9)	88-92 av. 90.4	10.5-12.3 av. 11.6	21.4-23.4 av. 21.9	51-55 av. 53.4
	(IH 88-94	from skull 14-15	22-26	51-56)
		1781 Prunella rubeculoides		
Male (2)	77, 80	10.5, 11.6	23.9, 24.2	56, 58
	(IH 75-86	from skull 13-15	23-24	59-69)
Female (1)	78	12.1	21.8	65
	(IH 72-79	from skull 13-15	23-24	60-65)
		1782 -83 **Prunella strophiata** subspp.		
Male				
1782 *jerdoni* (4)	65-72 av. 67.7	10.2-12 av. 10.9	18.5-20.1 av. 19.2	50-55 av. 53.5
	(IH 62-73	from skull 13-15	21-23	55-67)
1783 *strophiata* (7)	66-72 av. 69.4	10.6-11.5 av. 11.1	19- 21.5 av. 20.5	54-64 av. 59.4
Female				
jerdoni (7)	63-70 av. 66.2	10-11 av. 10.67	18.5-20 av. 19.1	50-55 av. 52.4
	(IH 60-67	from skull 13-15	21-23	46-67)
strophiata (3)	64, 65, 66	11.2, 11.4, 11.5	19.5, 19.8, 20.5	55, 56, 60
	(IH measurements as in 1782)			
		1784/85 **Prunella fulvescens** subspp.		
Male				
1784 *fulvescens* (1)	75	11.2	19.5	61
	(IH 71-81	from skull 13-15	*c.* 20	61-68)
1785 *sushkini* (1)	72	10	20.5	60
	(IH unrecorded, probably as in 1784)			
Female				
fulvescens (2)	70, 72	11.2, 11.4	20, 20.5	58, 60
	(IH 72-79	from skull 13-15	*c.* 20	59-66)
		1786 Prunella atrogularis huttoni		
Male (4)	74-78 av. 75.5	10.5-11.4 av. 11.1	20.1-21.5 av. 20.6	60-65 av. 63.2
	(IH 70-79	from skull 13-15	–	60-71)
Female (4)	71-74 av. 73	10.7-11.4 av. 11.1	20-20.8 av. 20.3	58-64 av. 61.7
	(IH 71-77	from skull 12-15	–	59-68)
		1788 Prunella immaculata		
Male (1)	81	12	22	57
	(IH 76-87	from skull 13-15	22-25	55-59)
Female (2)	77, 78	11.4, 11.9	21, 21.1	53, 55
	(IH 74-81	from skull 13-15	22-25	50-59)
		1789 Melanochlora sultanea sultanea		
Male (17)	102-112 av. 108.1	14.2-16.1 av. 14.9	21-23.9 av. 22.8	83-96 av. 90.7
	(IH 103-113	from skull 16-18	22-26	93-98)
Female (11)	94-108 av. 102	14-15.9 av. 15.1	21.24 av. 22.6	80-90 av. 86.5
	(IH 95-108	from skull 15-16	22-26	85-93)

	Wing	Bill	Tarsus	Tail
	1790-97 **Parus major** subspp. & ELs			
Male				
1792 *caschmirensis* (6)	69-79 av. 72.5	10-11 av. 10.4	17.5-18 av. 17.6	60-68 av. 63
	(IH 72-78	from skull 12-13	17-20	60-71)
1793 *nipalensis* (6)	65-70 av. 68.1	10-10.3 av.10.1	17.2-18 av. 17.5	58-61 av. 59.1
	(IH 63-71	from skull 11-12	16-17	55-61)
1794 *stupae* (19)	62-72 av. 66	9.3-10.8 av. 10	15.8-17.5 av. 16.7	51-61 av. 55.2
	(IH 60-73	from skull 10-12	17-19	47-61)
1796 *vauriei* (3)	64, 65, 66	10,10,10.1	16.5, 17.4, 17.5	55, 55, 58
	(IH 1 M (Type) 59	from skull 10.5	–	53.5)
EL *commixtus* (1)	67	–	17.8	60
	(Baker MF 61-68	–	–	53-61)
EL *minor* (2)	73 (2)	9.7, 10	17.3, 17.8	63, 64
	(Dementiev 60.5-66.5	av. 63.1)		
EL *major* (1)	76	10.5	20.5	64
	(BHB 73-79	from skull 10-11	19-21	60-68)
EL *intermedius* (4)	73-77 av. 75	10.3-11 av. 10.7	19-19.9 av. 19.5	60-66 av. 63.2
	(Baker MF 68-75	–	–	52-63)
EL *blanfordi* (2)	74, 78	11.2	19(2)	63, 64
Female				
1790 *ziaratensis* (1)	72	9.5	17.2	54
	(IH 66-71	from skull 11	–	60-72)
1792 *caschmirensis* (5)	67-72 av. 69.4	10-10.5 av. 10.1	17.2-18.8 av. 18.1	54-59 av. 56.6
	(IH 68-73	from skull 11-13	18-20	56-62)
1793 *nipalensis* (3)	66, 68, 69	9.9, 10, 10.5	17.5, 17.8, 18	57, 58, 60
	(IH 59-66	from skull 11-12	16-17	53-54)
1794 *stupae* (12)	60-65 av. 62.2	9.3-10.7 av. 9.8	16-18 av. 16.9	48 -54 av. 51
	(IH 61-69	from skull 11-12	17-20	48-58)
1796 *vauriei* (1)	60	9.4	–	52
EL. *commixtus* (1)	63	11	18.4	58
EL. *intermedius* (3)	70, 70, 75	10.5, 10.7, 11.5	17.9, 18.2, 18.9	58, 60, 61
EL. *blanfordi* (2)	68, 72	10.9, 11	17.8, 18.8	56,
	1798 **Parus nuchalis**			
Male (7)	64-71 av. 68.2	10-10.7 av. 10.4	17.5-19.5 av. 18.4	50-54 av. 51.4
	(IH 65-71	from skull 11-13	17-19	48-55)
Female (3)	66 (2), 67	10, 10.3, 10.5	17.5, 17.6, 17.7	50 (3)
	(IH 67-68	from skull 11-12	17-19	49-53)
	1799 **Parus monticolus monticolus**			
Male (23)	64-72 av. 67.5	9.5-10.5 av. 9.9	17.5-20 av. 18.2	50-59 av. 54.1
	(IH 65-71	from skull 11-12	18-19	54-57)
Female (13)	63-69 av. 65.6	9.5-10 av. 9.7	17.5-19 av. 18.1	45-56 av. 51.4
	(IH 63-70	from skull 11-12	18-19	53-56)

	Wing	Bill	Tarsus	Tail
		1800 Parus cyanus flavipectus		
Male (1)	67	9.7	17.5	58
	(Dementiev 63-68)			
Female (1)	64	9.8	17.8	55
	(Dementiev 61-64)			
		1802 Parus melanolophus		
Male (17)	60-65 av. 62.8	9-9.7 av. 9.3	16.5-17.8 av. 17	39-45 av. 42.5
	(IH 60-68	from skull *c.* 11	*c.*17	41-46)
Female (6)	59-63 av. 61.1	8.5-9.5 av. 9.1	16.5-17.8 av. 17.2	39-43 av. 40.8
	(IH 58-66	from skull *c.* 11	*c.*17	40-46)
		1803 Parus ater aemodius		
Male (3)	60, 61, 63	8.1, 8.7, 8.9	15.5, 16.2, 16.8	40, 42, 43
	(IH58-62	from skull 9-10	16-18	40-42)
Female (3)	56, 60, 61	7.7, 8.7, 9.2	16, 16.5, 17.3	39, 40, 42
	(IH 55-61	from skull 9-10	16-18	40-42)
		1804-6 Parus rubidiventris subspp.		
Male				
1804 *rufonuchalis* (10)	73-79 av. 76.3	10.2-11.5 av. 10.9	18.5-20 av. 19.3	48-55 av. 52.6
	(IH 71-78	from skull 12-13	19-20	51-56)
1805 *rubidiventris* (1)	69	9.5	17.3	46
	(IH 67-71)			
1806 *beavani* (3)	68, 70, 71	9.4, 9.5, 9.8	19, 19.5, 19.6	45, 48(2)
	(IH 67-75	from skull *c.* 10	20-21	45-52)
Female				
1804 *rufonuchalis* (9)	70-75 av. 72.7	10.5-12.5 av. 11.1	18.2-20 av. 19.2	50-55 av. 51.2
	(IH 74-75	from skull 12-13	19-20	51-56)
		1807-8 Parus dichrous subspp.		
Male				
1807 *kangrae* (1)	73	9.6	19	46
	(IH 65-74)	from skull *c.* 10	*c.* 20	48-51)
1808 *dichrous* (2)	71 (2)	8.5, 9.8	19.6, 19.8	47, 49
	(IH as in 1807)			
Female				
1807 *kangrae* (2)	66 (2)	9.3, 9.5	18.7, 19.2	43, 45
	(IH 65-70	–	–	47-50)
1808 *dichrous* (1)	69	–	19.3	45
		1809-11 Parus xanthogenys subspp.		
1809 *xanthogenys* (11)	70-74 av. 72	10.5-11.5 av. 10.8	17.5- 18.9 av 18.2	53-56 av. 55.1
	(IH 67-76	from skull 12-13	18-19	50-60)
1810 *aplonotus* (17)	66-77 av. 71.1	10.2-11.5 av. 10.8	18.5- 20.2 av. 19.1	50-58 av. 53.8
	(IH 70-78	from skull 11-13	18-20	52-60)

	Wing	Bill	Tarsus	Tail
		1809-11 Parus xanthogenys subspp. (contd.)		
1811 *travancoreensis* (17)	73-79 av. 75.8	10.8-12 av. 11.3	18.5-21 av. 19.4	53-62 av. 56.6
	(IH 71-82	from skull 12-14	19-20	54-62)
Female				
xanthogenys (3)	71, 72 (2)	10.5, 11, 11.1	18 (3)	54, 55
	(IH 65-72	from skull 12-13	18-19	50-54)
aplonotus (13)	65-73 av. 68.9	10.2-11 av. 10.5	18-2 0 av. 18.5	48-53 av. 51.4
	(IH 66-71	from skull 11-13	18-20	49-53
travancorensis (5)	70-76 av. 72.2	10.7-11.1 av. 10.9	18-20 av. 18.9	51-55 av. 53
	(IH 68-76	from skull 12-14	19-20	51-57)
		1812 Parus spilonotus spilonotus		
Male (8)	75-78 av. 76.7	10-11.5 av. 11.1	18.5-19.5 av. 19.1	50-56 av. 53.2
	(IH 71-84	*c.* 11	*c.* 18	58-63)
Female (6)	72-79 av. 74.8	10-11.6 av. 10.9	18.5-20 av. 18.9	50-57 av. 52
	(Baker MF 72-78	*c.* 10-11	*c.* 22	*c.* 58
		EL. Parus palustris hellmayri		
Male (2)	59, 62	8.5, 8.6	15.5, 15.7	51, 52
Female (2)	58, 59	9, 9.5	15, 15.6	48, 49
		1813-14 Sylviparus modestus subspp.		
Male				
1813 *simlaensis* (4)	58-61 av. 59.7	6.2-8.3 av. 7.3	15.2- 16.1 av. 15.6	35-37 av. 36
	(Baker MF 60-64	*c.* 5	*c.* 15	*c.* 35)
1814 *modestus* (5)	53-65 av. 59.8	6.6-8.3 av. 7.8	15.2-16.3 av. 15.8	33-40 av. 38.4
	(IH 57-64	from skull 8-9	15-17	35-41)
Female				
1813 *simlaensis* (3)	58, 59 (2)	6.5, 6.8, 7.5	15 (2), 15.5	36 (2), 38
1814 *modestus* (4)	55-57 av. 55.7	7.8-8.3 av. 8	15-16.2 av. 15.6	34-36 av. 35
	(IH 54-62	from skull 8-9	15-17	33-39)
		1815-16 Cephalopyrus flammiceps subspp.		
Male				
1815 *flammiceps* (5)	60-62 av. 60.4	7-8 av. 7.6	13.5-15.5 av. 14.3	30-34 av. 31.2
	(IH MF 58-64	from skull 9-10	13-15	30-33)
1816 *olivaceus* (3)	59 (2), 60	7.2, 7.3, 7.7	13.5-15.5 av. 14.3	30-34 av. 31.2
	(IH MF 59-60	from skull 10-10	15-16	32-35)
Female				
1815 *flammiceps* (4)	59-64 av. 61.7	7.6-8.5 av. 7.9	13.6-16 av. 14.4	29-33 av. 31.2
		1817 Remiz pendulinus coronatus		
Male (3)	53 (3)	7, 7.8, 8	13.3, 14 (2)	28, 42 (2)
	(IH 50-54	from skull 10-11	13	40-44)
Female (7)	51-53 av. 52	7.5-8.5 av. 8	13-14 av. 13.3	39-43 av. 40.1
	(IH 52-54	from skull 10-11	13	39.43)

	Wing	Bill	Tarsus	Tail
	1818-20 Aegithalos concinnus subspp.			
Male				
1818 *iredalei* (16)	51-55 av. 53.2	5.3-6.8 av. 6.3	15-17 av. 16.3	47-54 av. 49.4
	(IH 53-57)			
1819 *rubricapillus* (5)	48-51 av. 49.6	6-6.5 av. 6.2	15.5-17 av. 16. 2	47-50 av. 48.4
	(IH 47-55	from skull 7-8	16-17	48-53)
Female				
1818 *iredalei* (7)	51-56 av. 52.5	6.2-6.5 av. 6.3	15.5-16.6 av. 16	43-55 av. 47.8
	(IH 49-52)			
1819 *rubricapillus* (2)	48, 49	5.5, 6.5	16, 16.2	46, 48
	(IH 45-52	from skull 7-8	16-17	43-50)
	1821 Aegithalos leucogenys			
Male (3)	53, 55, 57	6.5, 7, 8.5	17.1, 18 (2)	45, 48, 50
	(IH 57-59	from skull *c.* 8	*c.* 17	53-57)
Female (2)	53, 58	7.1, 7.2	15.5, 18.5	50, 53
	(IH 52-55	from skull *c.*8	*c.* 17	49-52)
	1823 Aegithalos iouschistos iouschistos			
Male (4)	56, 57, 58 (2)	7.2 (2), 7.5 (2)	17, 17.2 (2), 17.3	50, 51, 52, 54
	(IH MF 53-60	from skull 9-10	17-19	45-53)
	1824-26 Sitta europaea subspp.			
Male				
1824 *cashmirensis* (1)	85	–	19	43
	(IH 82-86	from skull 21-23	17-18	42-44)
Female				
1824 *cashmirensis* (3)	84, 85, 87	15.6, 17.5, 19.5	16.9, 18.4, 18.5	42, 43, 46
	(IH 81-86	from skull 20-23	17-18	42-44)
	1827-31 Sitta castanea subspp. & EL			
Male				
1827 *almorae* (4)	82, 84, 85, 86	18.5, 18.7, 19, 19.5	18.5, 19, 19.3, 19.7	40 (2), 41, 42
	(IH 81-87	from skull 21-24	18-20	40-44)
1828 *cinnamoventris* (11)	79-86 av. 82.1	17-19.3 av. 18	18- 20 av. 19.3	38-43 av. 40.9
	(IH81-86	from skull 19-22	18-21	38-45)
1830 *castanea* (13)	72-81 av. 74.3	15.5-17.5 av. 16.6	16.6- 18.5 av. 17.5	35-40 av. 37.6
	(IH 72-82	from skull 18-21	17-19	36-42)
1831 *prateri* (6)	76-81 av. 78.5	16.1-18. 5 av. 17.6	16.5-19 av. 18.1	37-42 av. 39
	(IH 77-83	from skull 21-22	17-19	40-43)
EL *neglecta* (1)	79	17.3	17.4	40
Female				
1827 *almorae* (2)	80, 83	19.2, 19.6	18, 18.2	39 (2)
	(IH 78-85	from skull 21-24	18-19	40-48)
1828 *cinnamoventris* (5)	76-80 av. 77.8	16.4--18.7 av. 17.4	18-18.8 av. 18.3	36-40 av. 38
	(IH 77-83	from skull 18-22	17-20	38-41)

	Wing	Bill	Tarsus	Tail
1830 *castanea* (9)	70-79 av. 73.5	16-17.7 av. 16.6	17-18.5 av. 17.5	35-41 av. 36.4
	(IH 71-78	from skull 18-20	17-19	35-41)
1831 *prateri* (5)	73-76 av. 74.4	16.9-18.3 av. 17.3	17.2-19 av. 17.9	35-38 av. 36.6
	(IH 75-78	from skull 20-22	17-19	38-41)
EL *neglecta* (1)	75	16	17.1	36
	(Baker MF 75-78	*c.* 17	*c.* 18	38-42)
1832 Sitta leucopsis leucopsis				
Male (3)	75, 79, 80	17.5 (2), 18.7	17.5, 18, 18.3	39, 40, 42
	(IH 74-79	from skull 22	18-19	39-40)
Female (5)	70-78 av. 76	17-17.2 av. 17.1	17.7-18.7 av. 18.2	37-41 av. 39.6
	(IH 73-75	from skull 21	18-19	39-40)
1834 Sitta himalayensis himalayensis				
Male (a) (7)	74-79 av. 76.4	13-14.2 av. 13.6	17.5-18.5 av. 18.1	34-38 av. 36.2
(b) (8)	71-78 av. 73.7	12.9-14.5 av. 13.4	17-18.4 av. 17.5	35-38 av. 36.7
	(IH 69-77	from skull 15-19	17-21	35-42)
Female (a) (7)	70-76 av. 73.7	13.2-14.3 av. 13.6	17-18.2 av. 17.7	34-37 av. 35.5
(b) (8)	67-74 av. 71.7	12.9-14.1 av. 13.5	16.5-18 av. 17.2	34-38 av. 35.7
	(IH 68-76	from skull 15-19	17-21	33-40)
1836 Sitta tephronota subspp. & EL				
Male				
tephronota (4)	84 (2), 85, 89	20.7, 21.7 (2), 22.8	24.5, 25, 25.5, 26.4	46, 47, 48, 52
	(Vaurie 85-90	from skull 26-27)		
EL *dresseri* (3)	90, 91 (2)	22.5 (2), 22.7	26.7, 27.6, 28.2	47, 50,
Female				
tephronota (5)	82-86 av. 84.2	20-22.7 av. 21.6	22.9-25 av. 23.9	46-48 av. 47
	(Vaurie 85-88	from skull	26-29)	
EL *dresseri* (8)	87-91 av. 89	22.7-25 av. 23.8	25.3-27.8 av. 26.7	45-50 av. 47.1
	(Ticehurst 90	from skull 28.5)		
1838 Sitta frontalis frontalis				
Male (21)	71-80 av. 75.5	11-13.8 av. 12.3	16-17.5 av. 16.5	36-43 av. 39.9
	(IH 70-82	from skull 15-16	15-17	37-45)
Female (21)	70-79 av. 73.4	11.3-13.5 av. 12.3	16-17 av. 16.3	34-41 av. 38.1
	(IH 69-80	from skull 15-16	15-17	35-44)
1839 Tichodroma muraria subspp. & EL				
Male				
nepalensis (10)	99-105 av. 101.9	23.3-26.3 av. 24.9	22-24.5 av. 22.9	54-62 av. 56.2
	(IH 100-115	from skull 26-30	22-26	53-58)
EL. *muraria* (1)	99	26.2	23	55
Female				
nepalensis (10)	97-102 av. 99.4	22.1-27.2 av. 24.9	22-25 av. 23.3	51-59 av. 54.1
	(IH 92-104	from skull 26-30	22-26	57-60)

	Wing	Bill	Tarsus	Tail
	1840-41 Salpornis spilonotus subspp.			
Male				
1840 *rajputanae* (1)	92	23	16.3	51
	(IH 90	from skull 25, 26	17	52, 53)
1841 *spilonotus* (2)	89,93	21.8, 23.2	16.7, 17.2	50, 54
	(IH 90	from skull 25, 26	17	52, 53)
Female				
spilonotus (1)	87	23.9	17	50
	(IH 87-89	from skull 24-28	17	49-51)
	1842 -44 Certhia familiaris subspp. & EL			
Male				
1843 *mandelli* (1)	69	14	16.7	55
	(IH 63-70	from skull 15	17	55-57)
Female				
1843 *mandelli* (3)	65 (2), 66	12.4, 14, 14.5	16, 16.3, 16.7	55, 57 (2)
	(IH 63-66	from skull 13	17	55)
EL *bianehi* (2)	64, 65	13, 14	15	55, 57
	1845-48 Certhia himalayana subspp.			
Male				
1845 *limes* (2)	73, 74	19.2, 21.8	16.4	66, 67
	(IH 73, 74	from skull 23-25	15-16	68-69)
1846 *taeniura* (1)	75	20.8	17.3	67
	(Dementiev 69-72	from skull 22-25)		
1847 *himalayana* (8)	68-73 av. 70.6	18.2-19.7 av. 18.7	15-16.5 av. 15.8	59-69 av. 63.8
	(IH as in 1845)			
Female				
limes (6)	65-70 av. 67.8	16.5-19.5 av. 17.6	15-16.5 av. 15.6	59-63 av. 60.6
	(IH 66-72	from skull 18-21	15-16	60-66)
taeniura (1)	68	17.6	16.4	62
	(Demen tiev 64-68	from skull 22-25)		
himalayana (3)	67, 68, 71	15, 17.5, 18	15, 15.3, 16	62, 63, 67
	(IH as in 1845)			
	1849 Certhia discolor discolor			
Male 16	66-72 av. 69.4	14.3-15.8 av. 15.1	17-18.3 av. 17.6	69-78 av. 74.4
	(IH 67-76	from skull 17-20	17-20	73-82)
Female (4)	66, 67(2), 68	13.8, 14.2, 14.3, 14.5	17.1, 17.3, 17.5(2)	68, 71, 72, 73
	(IH 64-72	from skull 16-18	17-18	73-77)
	1851 Certhia nipalensis			
Female (1)	70	11.6	18	69
	(IH 66-71	from skull 14-17	18-20	69-76)

BIOECOLOGICAL STUDIES ON THE BURROWING MAYFLY *EPHEMERA (AETHEPHEMERA) NADINAE* MCCAFFERTY AND EDMUNDS 1973 (EPHEMEROPTERA : EPHEMERIDAE) IN KURANGANI STREAM, WESTERN GHATS [1]

C. BALASUBRAMANIAN, K. VENKATARAMAN AND K.G. SIVARAMAKRISHNAN [2]

(With three text-figures)

The life cycle pattern of *Ephemera nadinae* in Kurangani stream was interpreted from the developmental stage frequency histograms. It is basically multivoltine with asynchronous, overlapping generations or cohorts with continuous emergence. Food habits of *E. nadinae* were investigated. Detritus forms the major food. Meagre amount of minerals and plant tissues were noted in the gut, which might have been consumed with normal food incidentally. The emerging behaviour of subimagos was also studied. They emerge soon after sunset at about 1830 hrs throughout the year. Synchronous emergence of both sexes was recorded, with males outnumbering females. Subimagos emerge on the water surface. Longevity of the adults ranges from 24 to 48 hours. The average number of eggs/mm of body length in *E. nadinae* was 240 (r value = 0.9). The fecundity of *E. nadinae* is compared with co-existing species of lotic mayflies.

INTRODUCTION

Knowledge of ecology and life histories of all important groups of aquatic insects is essential in understanding the biological structure of freshwater streams and lakes. Ecological studies on lotic systems in India with emphasis on Ephemeroptera are very few (Gupta 1980, Sivaramakrishnan and Job 1981, Venkataraman 1984, Kumar 1987). Though there are a number of studies on life cycles of ephemerids inhabiting temperate regions (Kuroda *et al.* 1984, Schloessor and Hiltunen 1984), there is a paucity of information on the life cycle patterns of tropical ephemerids including peninsular Indian forms. This study examines the life cycle pattern, feeding propensities, emergence and fecundity of *Ephemera nadinae*, a burrowing mayfly, in a third order stream in Kurangani village of the Cardamom hills of Western Ghats.

STUDY AREA

Kurangani (11° N, 77°50'E), the study area, is situated 116 km west of Madurai, Tamil Nadu. It lies on the north-eastern side of the Cardamom hills at an altitude of 650 m above m.s.l. This area is exposed to the effects of the south-west monsoon, the north-east monsoon and summer. For ecological studies, February through May are treated as summer, June through September as south-west monsoon period and October through January as north-east monsoon period.

MATERIAL AND METHODS

The study was conducted from February 1988 to January 1989. Three kick samples of ephemerids were collected from sandy regions of Kurangani stream. The sandy habitat was disturbed preferably by five horizontal and five vertical vigorous kicks strictly restricted to one square metre area. Nymphs thus collected were preserved in 70% alcohol and were sorted according to age-class. The plan of Clifford (1969) was followed and in the classification of stages, nymphs were grouped into four arbitrarily chosen developmental stages on the basis of appearance and the development of mesothoracic wing pads. Stage I nymphs lacked wing pads; stage II nymphs had wing pads that were shorter in length than the distance separating the two wing pads; the wing pad length of stage III nymphs was greater than the distance separating the fore wing pads. Stage IV nymphs had darkened wing pads.

Each stage represents several instars, with the exception of stage IV, which is the last nym-

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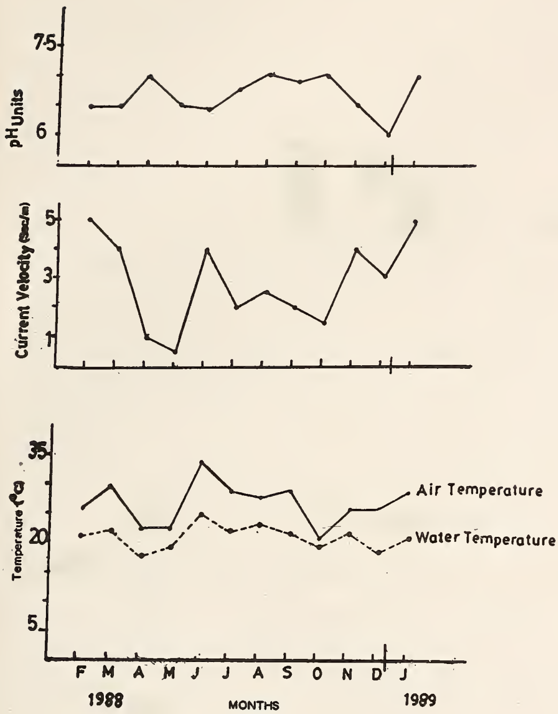

Fig. 1. pH, current velocity and air and water temperature in Kurangani stream, at monthly intervals from February 1988 to January 1989.

phal instar, the tan wing pads indicating impending emergence. Nymphs were sexed only after stage II on the basis of genitalia.

Physico-chemical parameters were recorded during collection time. During each visit atmospheric and water temperatures were recorded. Water velocity was determined by the cork floatation method. pH of water was noted with the help of BDH broad and narrow range pH indicator papers.

The method employed for food analysis is a combination of the methods followed by Minshall (1967) and Gupta and Michael (1981). Nymphs were collected at monthly intervals, fixed immediately in 70% alcohol, and later sorted in the laboratory. Five to ten nymphs of assorted varieties in every month were used for gut analysis. Stage IV nymphs were not used for gut analysis as they were almost ready to emerge and hardly ingested any food at the time. The foregut portion up to second abdominal segment was dissected and the contents were rolled out and teased. The suspension of the food material was transferred to Sedgewick rafter. The suspension was allowed to stand for some time to allow sediments to settle. The percentage composition was determined by counting the cells of Sedgewick rafter of different food materials. using a compound microscope.

Subimaginal emergence was monitored during south-west monsoon, north-east monsoon and summer periods. Monthly trips were made to Kurangani and light trapping was done with a125 watt mercury vapour lamp powered by a portable generator. Light was switched on from 1800 to 2030 hrs and from 0500 to 0630 hrs. Subimagos were collected in subimaginal box cages (Edmunds *et al.* 1976). Longevity (emergence to imago-death interval) was determined in the subimaginal box cages at room temperature (28 ± 2°C) in the laboratory.

Fecundity is the total number of eggs produced by the female during her life span, regardless of the fate of the eggs. For meaningful comparison between species, the relationship between egg production of *E. nadinae* and body length was analysed. The eggs from the abdominal and thoracic body cavities of last instar (with darkened wing pad) nymphs of *E. nadinae* were removed to Sedgewick rafter and counted. The relationship between fecundity and body length was statistically analysed.

Results and Discussion

Life cycle pattern: The physico-chemical parameters like temperature, pH and water velocity of Kurangani stream are shown in Fig. 1. pH of the stream tended to decrease during southwest monsoon and to increase during summer. The atmospheric and water temperatures

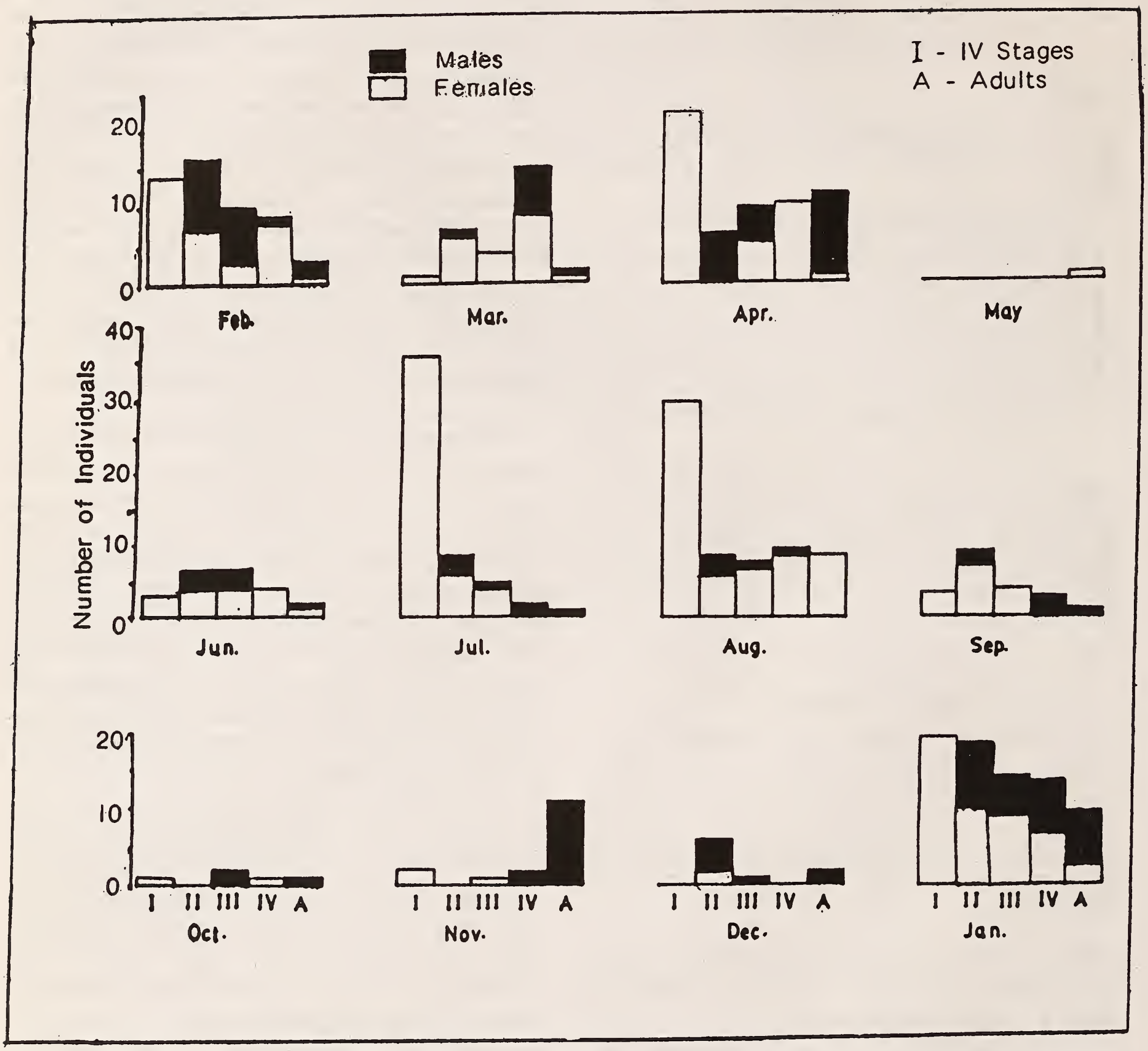

Fig. 2. Monthly changes in the distribution of *E. nadinae* adults and nymphs.
A – indicates months when emerging mayflies were found.

showed large fluctuations during different seasons.

Several factors are known to influence the distribution of aquatic insects. But important environmental factors likely to affect animal number within a very small segment of the stream are water velocity (Scott 1958, Ambuhl 1959, Jaag and Ambuhl 1964, Edington 1968), substratum (Rabeni and Minshall 1977, Shaw and Minshall 1980) and food (Egglishaw 1964, 1969; Williams and Hynes 1973).

The life cycle pattern of *E. nadinae* in Kurangani stream is interpreted from developmental stage frequency histograms (Fig. 2). It is basically

multivoltine with asynchronous, overlapping generation or cohorts with continuous emergence. A cohort is a group of individuals that were born at the same time, or in practice born over a short period of time. Early instars of *E. nadinae* occur around July and this cohort continues up to November. Besides, the presence of two other cohorts which occur during January and April is suggested.

The life cycle patterns of ephemerids from temperate regions show agreement as well as deviation from the observed pattern. For instance, the life cycles of *E. japonica* and *E. orientalis* also have two or three cohorts in a year, suggesting multivoltine pattern, whereas *E. strigata* is evidently univoltine in having only one cohort (Kuroda *et al.* 1984). The life cycle of *Hexagenia limbata* of St. Marys river, Michigan, is composed of two non-synchronous emerging cohorts each with a two-year life span (Schloessor and Hiltunen 1984).

Feeding propensities: Mayfly nymphs do not play the same role in the trophic structure of the communities in which they occur. In view of this, knowledge of their feeding habits is desirable (Brown 1961). Studies on food habits of tropical and subtropical mayflies are very few (Sivaramakrishnan 1980, Gupta and Michael 1981, Venkataraman 1984). In the present investigation, detritus formed the major food. Studies by Venkataraman (1984) on nymphs of heptageniids of Palani hill streams reveal that they are algivores, whereas the same species and some leptophlebiids of Courtallam hill streams are detritivores (Sivaramakrishnan 1980).

The absence of canopy formation by forest trees on the banks of Kumbakkarai stream in Palani hills favours algal growth in rocky bottom. The limited vegetation near the bank may be correlated with minimal amount of allochthonous detritus. The condition in Courtallam hill streams is different, with poor access to direct sunlight over the stream due to canopy formation. Kurangani stream is in this respect similar to Courtallam streams. The statement that local conditions beget local results (Muttowski and Smith 1929) holds good for explaining the food habits of Ephemeroptera or even other groups of aquatic insects (Cummins 1973). Gut content analysis of *E. nadinae* revealed a meagre amount of minerals and plant tissues which might have been consumed with normal food incidentally.

Emergence: Emergence is probably a 'safety in numbers' strategy evolved to maximise survival from predation at one of the vulnerable periods in the life cycle of mayflies (Friesion *et al.* 1980). In the present investigation, *E. nadinae* emerged after sunset (around 1830 hrs throughout the year). Similar dusk emergence was observed by Takemon (1985) in *E. japonica*. He observed *E. strigata* to emerge in the afternoon. Synchronous emergence of both sexes of *E. nadinae* was recorded, with males outnumbering females. As against the male-biased emergence, female-biased emergence has been recorded in some tropical mayflies (Poyyamoli 1984, Venkataraman 1984).

Edmunds and Edmunds (1980) point out that apparently many of the activity patterns and adaptations of mayfly subimagos and imagos have formed in response to selection pressure from predators. Mayfly subimagos, being slow and clumsy fliers, are highly vulnerable to predation.

Nocturnal emergence observed in the present study may be attributed to the following reasons as suggested by Poyyamoli (1984) and Takemon (1985):

(1) The cuticle of newly emerged adults will be thin. As a result, they have to emerge during cooler hours, when evaporation is at its lowest. Night time in tropics is ideal.

(2) Nocturnal emergence helps these insects to escape from visual predators.

The emerging behaviour of *E. nadinae* of Kurangani stream was found to be of the water surface type and the behaviour is similar to *E. strigata* of Japan (Takemon 1985). However, nymphs of *E. japonica* after reaching the surface swam directly ahead along the surface with forelegs stretched forward until they came into contact with a partially submerged object such as a rock or plant. The longevity of adults (emer-

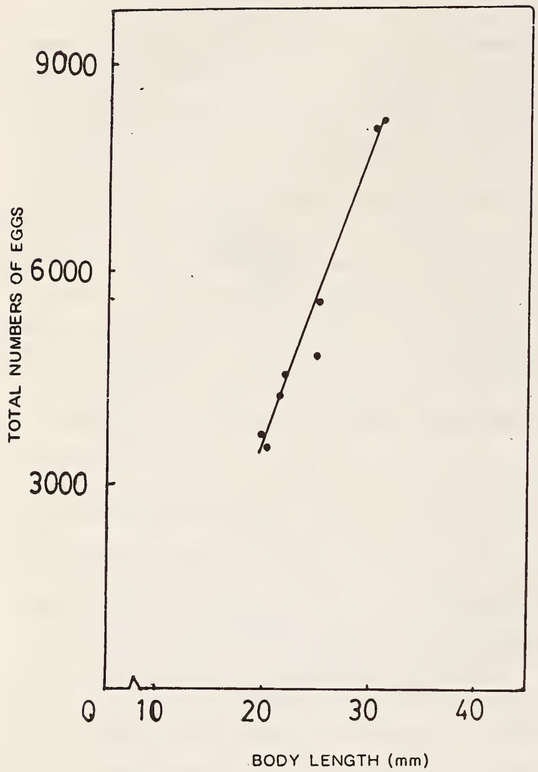

Fig. 3. Relationship between body length and number of eggs in *E. nadinae*.

gence to imago-death interval) of *E. nadinae* ranged from 24 to 48 hours.

Fecundity: The correlation between the number of eggs produced by *E. nadinae* and the body length is presented in Fig. 3. It confirms the general view that fecundity increases with increasing body length of the nymphs. However, Minshall (1967) found that beyond a size range (10.5 mm) the number of eggs decreased with increasing size of the individual. This apparent decline in egg number with increasing body size (up to 31 mm) has not been observed in the present study.

The average number of eggs/mm of body length in *E. nadinae* is 240 (r value = 0.9). The data of Clifford and Boerger (1974) for Bigory river mayflies of Canada, Hunt (1951) and Britt (1962) for Ephemerids and of Minshall (1967) and Venkataraman (1984) for Heptageniids would indicate 137-222 eggs/mm, 300-350 eggs/mm and 100-200 eggs/mm respectively.

Among the mayfly species, the burrowing Ephemeridae are the longest. But the rate of egg production is very high (1843 eggs/mm) only in Heptageniidae (Sridhar and Venkataraman 1989). The Ephemeridae are burrowing and sandy forms, whereas heptageniids are rheophilic and are restricted to torrential areas of rock-bottomed streams. This difference in ecological niche probably necessitates the production of more eggs to compensate for the loss of eggs being washed away (Sridhar and Venkataraman 1989).

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RELATIONSHIP BETWEEN CANOPY DENSITY AND BREEDING BEHAVIOUR OF *PLOCEUS PHILIPPINUS* (LINN.) AND *PLOCEUS BENGHALENSIS* (LINN.) [1]

SATISH KUMAR SHARMA [2]

(With two text-figures)

INTRODUCTION

The baya or Indian weaver bird *Ploceus philippinus* avoids heavy forest and prefers open cultivation (Whistler 1928). Such habitat selectivity could be observed prominently during the breeding season. Besides open cultivation, other similar open areas like scrub jungles (Mathew 1972), wells in the midst of bajra cultivation (Ali and Ambedkar 1957), isolated trees (Ali 1956), structures like house eaves (Davis 1971), telegraphic and power lines (Ambedkar 1970) are occasionally selected for hanging their nests. Adam (1873) has also noticed *P. philippinus* breeding in open plains in Rajasthan (Rajputana).

Like *P. philippinus*, *P. benghalensis* also avoids wooded areas (Ambedkar 1972). This species requires open grasslands and reed beds for nesting.

From the available literature, one can conclude that *Ploceus philippinus* and *P. benghalensis* are birds of open areas; but how much 'openness' they require, is not known so far. In the present paper the magnitude of 'openness' is quantified for two species of weaver birds in Rajasthan.

STUDY AREA

This study was conducted at Tatarpur Mixed Plantation A, B and C (27° 47′ N, 76° 31′ E) in Alwar district of Rajasthan. It is an undulating hilly area which is very prone to biotic interference. Earlier, this area was under dense forests; but due to overgrazing and illicit felling and lopping, the vegetative growth was destroyed. The area had become barren with stunted and sparse growth of *Prosopis spicigera*, *Zizyphus jujuba*, *Z. nummularia*, *Leptadenia sparitum*, *Calotropis procera*, *Acacia senegal*, *A. leucophloea*, *A. jacquemontii*, *Maytenus emarginata*, *Capparis decidua*, *C. sepiaria*, *Butea monosperma*, *Adhatoda vasica*, *Holoptelia integrifolia*, *Saccharum bengalense* and other grasses. In the upper reaches of the hills, *Anogeissus pendula*, *Acacia senegal* and *Rhus mysurensis* were dominant species.

The area lies between hill ranges, followed by agricultural land. Water sources are very limited. A small seasonal hill stream flows in the rainy season, but for a greater part of the year the area remain arid. The rainy season is July and August, with average rainfall of 696 mm. Rainy days are limited 50 to 70 days.

Bajra *Pennisetum typhoides* is the main monsoon crop.

In 1981, 66 ha of this area was fenced and taken up by Forest Department to develop a mixed plantation. The whole area was divided into three parts, A, B and C, with areas of 20, 23 and 23 ha respectively. The planting of seedlings was completed from July to August at a spacing of 5 x 5 m. *Acacia tortilis*, an exotic species, was introduced in the area on a large scale. *Dalbergia sissoo*, *Eucalyptus* spp., *Leucaena leucocephala*, *Parkinsonia aculeata*, *Acacia nilotica* and *A. auriculiformis* were also planted in the area.

MATERIAL AND METHODS

All three plantations were surveyed annually from May to October. The annual working schedule was as follows:

May to June: Canopy density was estimated every year from May to June, before commencement of monsoon. For this purpose, 10% random sampling of the area was done. Sample plots of 20 x 20 m size were laid out on the ground, using lime powder for demarcation of boundaries. Stones

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Table 1

NESTING OF *Ploceus philippinus* AT TATARPUR MIXED PLANTATIONS A, B AND C FROM 1980 TO 1990

Year	No. of colonies in plantations A (20 ha) Nest trees	Nests	B (23 ha) Nest trees	Nests	C (23 ha) Nest trees	Nests	Total 66 ha Nest trees	Nests
1980	0	0	8	44	11	34	19	78
1981	0	0	14	73	12	27	26	100
1982	18	57	27	128	21	178	66	363
1983	21	109	21	69	37	225	79	403
1984	33	171	23	77	31	192	87	440
1986	12	43	10	41	27	161	49	245
1987	3	20	1	4	30	42	34	66
1988	0	0	4	16	9	56	13	72
1989	0	0	6	36	10	78	16	114
1990	0	0	4	14	9	56	13	70

No data available for 1985.

Table 2

NESTING OF *Ploceus benghalensis* AT TATARPUR MIXED PLANTATIONS A, B AND C FROM 1980 TO 1990

Year	No. of colonies in plantations A (20 ha) Nested clumps	Nests	B (23 ha) Nested clumps	Nests	C (23 ha) Nested clumps	Nests	Total 66 ha Nested clumps	Nests
1980	23	44	5	11	9	22	37	77
1981	29	58	4	6	8	19	41	83
1982	33	63	6	13	11	24	50	100
1983	21	41	1	2	3	5	25	48
1984	19	29	0	0	7	14	26	43
1986	9	17	1	1	2	3	12	21
1987*	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0

An isolated nested tree or clump was considered as one colony. No data available for 1985.
**Saccharum bengalense* Retz. disappeared from the area from 1987 to 1990.

were partially buried on the boundaries of each plot to make their identification easier in coming years. Then a long light bamboo rod, with a sprit-level attached, carried in the vertical position (as checked by the spirit-level), was used to mark out as closely as possible the crown of each tree in each sample plot. The outline of each crown was drawn on the ground directly below the crowns; this represented the 'dripline' of the tree. The area occupied by an individual crown was estimated by dividing the area enclosed by the dripline into various geometrical figures. Canopy density was calculated as the ratio between total area occupied by the crowns and the sample plot area. The density scale therefore ran from 0 to 1 (entire area under canopy cover). Canopy density was classified into four categories:

(i) Closed – when the density is 1.0, (ii) Dense – density less than between 0.75 and 1.0, (iii) Thin – density between 0.50 and 0.75, and (iv) Open – density less than 0.50.

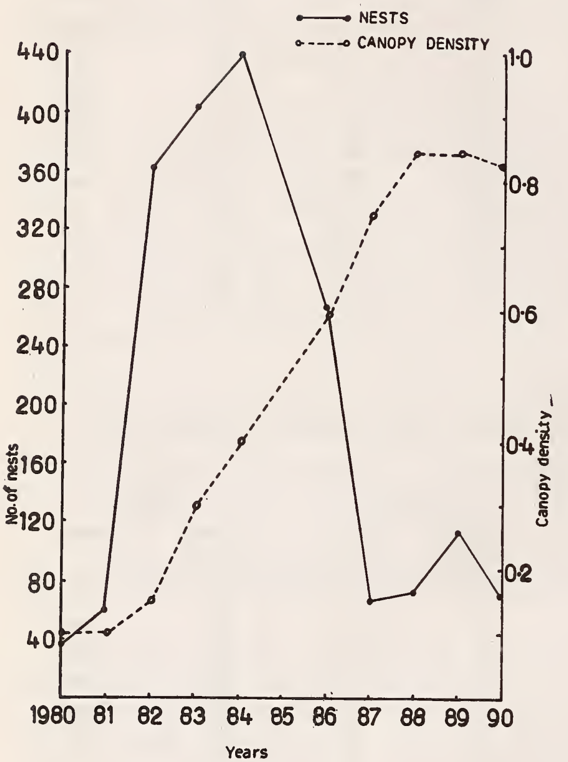

Fig. 1. Relationship between canopy density and number of nest colonies of *Ploceus philippinus* at Tatarpur Mixed Plantations A, B, C.

September to October: With the withdrawal of the south-west monsoon in September or October, breeding activities of weaver birds ceased. By this time the maximum numbers of the host trees and other forms of plants would have been engaged by breeders for colonisation. Trees and other forms of plants occupied by weaver birds for nesting were counted annually along with intact nests present on patronised plants (Tables 1, 2).

Results

Due to protection of the area and re-stocking of plantation, canopy density of the area increased gradually in subsequent years. The number of trees and other forms of plants occupied for nesting also increased correspondingly due to the following reasons:

(i) Minimization of biotic interference; (ii) availability of more suitable new host plants for nesting from planted crop; (iii) availability of additional host plants from degraded earlier natural growth due to protected regeneration; (iv) availability of fabricating material at nesting site from ungrazed *Saccharum bengalense* Retz. thickets.

The above relationship lasted until the crown contact stage was reached. After this stage, with further increment in canopy density, weaver birds were gradually displaced from the area. During later years, they abandoned the areas for nesting due to the gradual decrease in openness, and the shortage of nesting material, resulting from the natural eradication of fibre-yielding grass (*Saccharum bengalense* and others) due to lack of sunlight.

While most of the breeders were moving from the inner denser parts, many were still seen in the peripheral zone, using various plants for nesting but comparatively in smaller numbers (Figs. 1, 2).

With the gradual decrease of openness in the inner denser parts, weaver birds shifted their breeding activities to the peripheral zone at the outskirts of the plantation, where the wooded area thins out into open area. The 'canopy density' and 'crop density' generally remain low in this ecotonal zone due to biotic interference. Peripheral strips were therefore used for nesting in subsequent years.

No weaver bird nest colony was seen in area 'A' during 1990, due to the high canopy density in the area. Areas 'B' and 'C' were also neglected by *Ploceus philippinus* and only four and nine nest colonies respectively were seen in that year. Similarly, *Ploceus benghalensis* completely

TABLE 3
PROGRESS IN CANOPY DENSITY IN DIFFERENT YEARS AT TATARPUR MIXED PLANTATIONS A, B AND C FROM 1980 TO 1990

Year	Age of plantation in July	Condition of vegetation	Rainfall	Canopy condition	Approx. average canopy density at end of June
1980	–	Vegetation sparse, highly degraded, heavy biotic interference; *Saccharum bengalense* abundant.	Normal	Widely open	0.1
1981	0	Plantation done in July to re-stock the area; area fenced, biotic interference minimised, *Saccharum bengalense* abundant.	Normal	Widely open	0.1
1982	1	Vigorous growth in planted saplings, biotic interference minimised, *Saccharum bengalense* abundant.	Normal	Widely open	0.15
1983	2	Length-wise and sideways growth good, improvement in ground flora, biotic interference minimised, *Saccharum bengalense* abundant.	Normal	Open	0.3
1984	3	Expansion in crowns, development of microclimate continued, biotic interference minimised. *Saccharum bengalense* not flourishing in shady areas.	Sub-normal	Less open	0.4
1986	5	As in 1984.	Normal	Crown contact stage in a few pockets	0.6
1987	6	Along nallahs, canopy became closed; *Saccharum bengalense* disappeared from many shady pockets; illicit browsing practiced.	Severe drought	Crown overlapping started in a few pockets	0.75
1988	7	Besides a few pockets, most of the area became closed due to good crown growth; grassy ground flora disappeared from shady areas, *Saccharum bengalense* completely disappeared from most parts of the area.	Above normal	Crown overlapped in most of the area	0.85
1989	8	As in 1988. Illicit browsing continued.	Normal	As in 1988	0.85
1990	9	Illicit grazing, browsing with felling and lopping in many pockets. Fencing of barbed wire partially destroyed by graziers to facilitate illegal grazing.	Normal	As in 1988	0.83

No data available for 1985.

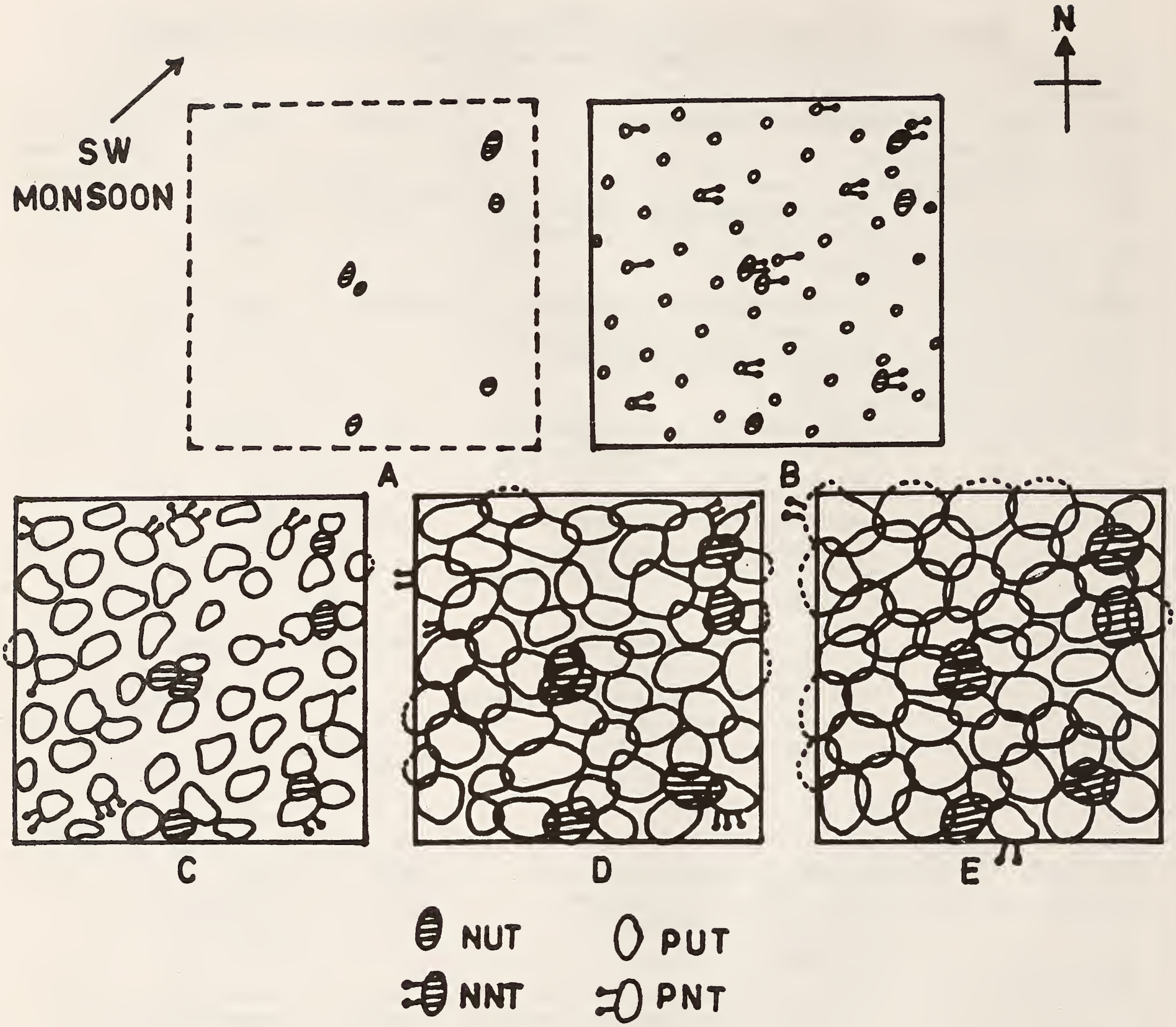

Fig. 2. Nesting patterns of *Ploceus philippinus* in the less undulating parts of Tatarpur Mixed Plantations.
A. 1980, before planting. Very few suitable nesting trees. Area unfenced. B. 1982: Canopy widely open. Area fenced. Planting at 5 x 5 m spacing done in 1981; both planted and earlier (natural) trees used for nesting. C. 1986, beginning of crown contact stage in some pockets; nesting activities shifted towards periphery. D. 1987, beginning of crown overlapping stage in some pockets, beginning of crown contact stage in most of remaining area. E. 1988, crown overlapping advanced. Nesting quickly disappeared in deeper parts.
NUT = Natural un-nested tree, NNT = Natural nested tree, PUT = Planted un-nested tree, PNT = Planted nested tree.

abandoned the area from 1987 onwards (Tables 1, 3).

Due to increase in canopy density, *Saccharum bengalense* also disappeared from the area for want of sufficient light. Before 1980, when this area was open, *Saccharum bengalense* was common. Before 1984, nest colonies of *Ploceus benghalensis* could be seen in sufficient numbers (Table 2), but after 1987, not even a single nest colony could be traced in any of the three plantations (Table 2).

Discussion

It is clear from the study that weaver birds cannot utilise man-made plantations year after year. Canopy density plays an important role as a limiting factor. A planted area is preferred by weaver birds till it reaches the 'crown contact stage'. Beyond this stage, weaver birds move from the area towards more open parts which are available within the area, or in other areas.

Openness of the area is important for several reasons:

(i) Thick growth reduces audibility of breeding songs of advertising cocks.

(ii) Nest building cocks display to attract the nest-inspecting females. Such displays cannot be seen if visibility in the area is poor. If there is thick growth around nesting hosts, neither the displaying cock nor his nest will be seen from a distance by females.

Besides audibility and visibility, one may suspect the effect of other causes such as influence of predators along with density of vegetative cover. Predation was not common in the area, and did not change in intensity during the study. A very few raids by house crows *Corvus splendens* were noticed in plantation 'C' on an *Acacia senegal* based huge colony of *Ploceus philippinus* in a nallah during 1982 and 1983. One incident of house crow attack was noticed in plantation 'B' in 1984.

The population of jungle crows *Corvus macrorhynchos* is extremely low in the locality and this species was never seen stealing eggs and chicks from the nests of weaver birds in the study area. Neither snakes nor raptors were noticed on weaver nests. However, once in the summer of May 1983, a grey shrike *Lanius excubitor* was noticed perching on the chinstrap of a half-built nest of *Ploceus philippinus*. However, shrikes were not observed hunting in the nest colonies during the breeding season of weavers.

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REPRODUCTIVE BIOLOGY OF THE HANUMAN LANGUR *PRESBYTIS ENTELLUS* IN JODHPUR, WESTERN INDIA[1]

G. Agoramoorthy[2]

(With four text-figures)

Introduction

The Hanuman langur *Presbytis entellus* Dufresene 1797 (Primates: Cercopithecidae), lives in a variety of habitats in India, which range from the snow-clad peaks of the Himalaya (up to 3660 m) in the north to deciduous forests in the south, parts of the Great Indian Desert in the west and to the rain forests in the east (Roonwal and Mohnot 1977).

Although a large number of field studies have been carried out on the behaviour and ecology of Hanuman langurs in different ecozones for the last two decades (Laws and Vonder Har Laws 1984 and references therein, Newton 1986, Sommer 1987), detailed information on the reproductive biology is not available (Harley 1985).

Adult male replacements, social changes and infant killings were frequently reported in this species (Sugiyama 1965, Mohnot 1971, Hrdy 1977, Makwana 1980, Sommer 1987, Agoramoorthy and Mohnot 1988, Agoramoorthy *et al.* 1988) but controversies still exist over different hypotheses in connection with frequency, cause and function of langur infanticide (Hrdy 1974, Curtin and Dolhinow 1978, Boggess 1979, 1984).

The collection of quantitative longitudinal reproductive and troop demographic data thus became important in order to test hypotheses concerning the functional aspect of infanticide. This paper describes the female reproductive parameters and troop development in three one-male bisexual troops of Hanuman langur. This study was carried out from December 1982 to September 1985 around Jodhpur in western India.

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Study Area

Jodhpur city (26°19' N, 73° 8' E, elevation 241 m) lies at the eastern fringe of the Great Indian Desert in western India. The study area named Kailana-Bijolai is located about 8 km west of Jodhpur, which has undulating hillocks in a semi-arid environment, where *Euphorbia caudicifolia* and *Acacia senegal* are predominant.

The climate of Jodhpur and its vicinity is characterised by uncertain and variable rains and extremes of temperature (Mohnot 1974). The lowest temperature during the study was 1° C (21 Feb. 1984) and the highest was 44.7° C (28 May 1984). Rain usually occurs in summer monsoons during July to September and the mean annual rainfall during 1983-84 was 360 mm.

Material and Methods

Langur troops: About 1300 langurs organized in 28 one-male bisexual troops (66.7%), one multi-male troop (2.4%) and 13 all-male bands (30.9%) are distributed in and around Jodhpur (Fig. 1). The total area used by these langurs comprises about 85 sq. km. There are no other langur troops found in a radius of 100 km around and thus the Jodhpur population is geographically and genetically isolated.

Water is available round the year for all the troops in the form of tanks, lakes and ponds. There are no natural predators except a few cases of dog predation (Agoramoorthy 1987). Religious people workship these langurs as God Hanuman (mentioned in the Hindu epic Ramayana), and provide them with artificial food regularly.

Study troops: The reproductive and troop demographic data presented here refer particularly to three one-male troops named B, KI and KII (Fig. 1).

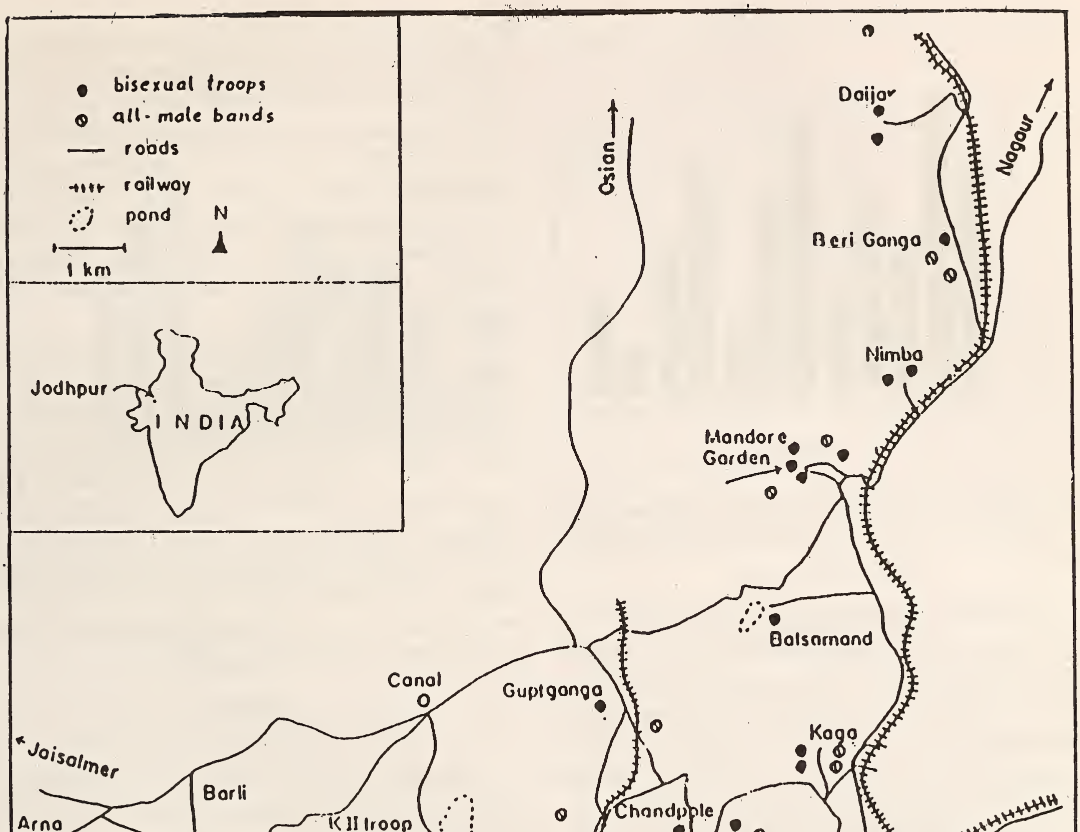

Fig. 1. Distribution of Hanuman langur troops around Jodhpur, western India.

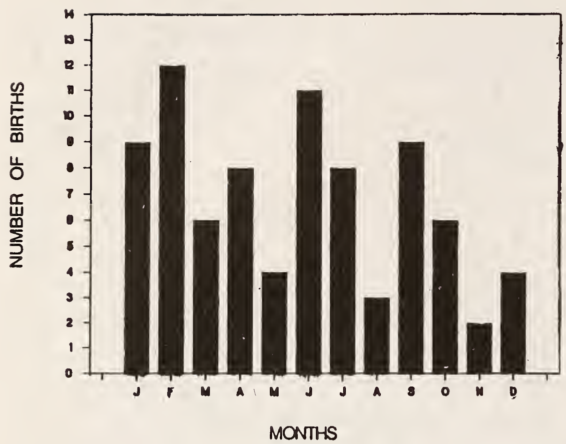

Fig. 2. Births observed during 1984 in 9 troops (2 multi-male, 7 one-male) of Hanuman langur, which are not influenced by infanticide.

Troop B or Bijolai troop: Troop B lives in Bijolai area and its home range overlaps that of neighbouring KII and B22 troops. Mohnot (1971) started to observe this troop in 1969 and was later followed by Makwana (1979), Winkler (1984) and Agoramoorthy (1987). All langurs of the troop were individually known since 1977.

Troops KI & KII (Kailana I & II): Prior to 1977, troops KI and KII were a single troop named B25 (Mohnot 1974). In 1977, fission occurred during a male band invasion into the troop (Winkler 1981). As a result, leader male of B25 continued its stay with 14 females, later named as troop KI. A new adult male along with eight females formed the second, named troop KII. Now troops KI and KII live in close proximity in Kailana area and their home ranges overlap. The past history of KI was published by Vogel and Loch (1984) and Winkler *et al.* (1984), whereas no earlier data was available on the individuals of troop KII. Individuals were identified and given names in July 1983, when I resumed regular observations.

Methods

The study troops were regularly observed from 10 December 1982 to 15 September 1985 for approximately 1850 hours to record the female reproductive parameters. All the individuals of the troops were checked every day to record new births, menstruation and sexual interactions with the leader male. As soon as a new born was seen, the last successful copulation date of the particular female was pooled out from reproductive records to estimate the length of gestation period. Ad libitum sampling was used as observational method (Altmann 1974).

Data on male band interactions with the focal troops and social changes like new male takeovers and infanticide were recorded. The influence of male takeover and infanticide in troop development was examined. To investigate birth seasonality in free ranging langurs around Jodhpur, nine bisexual troops (two multi-male and seven one-male troops) were followed once a week to record new births. Age of the infants was estimated based on colouration of face and coat (e.g. Mohnot 1974, Hrdy 1977).

Results

Female Reproductive Parameters

Births: Out of the total 41 infants that were born into the focal troops during 1982-85, one birth took place at dawn. When I resumed observation on 23 December 1983 at 0545 hrs, a new born infant was seen with the mother. The mother was in sitting posture, licking her infant. Fresh blood drops scattered around (15 cm radius) the place (over a rock) where the female was seen, indicated that the birth might have occurred about 30 minutes earlier. The infant was seen suckling with closed eyes. Six hours later, the infant was transferred to another female for about eight minutes. The vaginal bleeding lasted for four days.

In total, 17 infants were born in troop KII and 12 each in troop KI and B during the study period. Two distinct birth peaks were observed in this sample —a slow but steady increase in birth from January to March with a peak in March, and a sudden drop in April; and again a slow increase from May to July with another peak in July. This followed a gradual decrease in births, which were

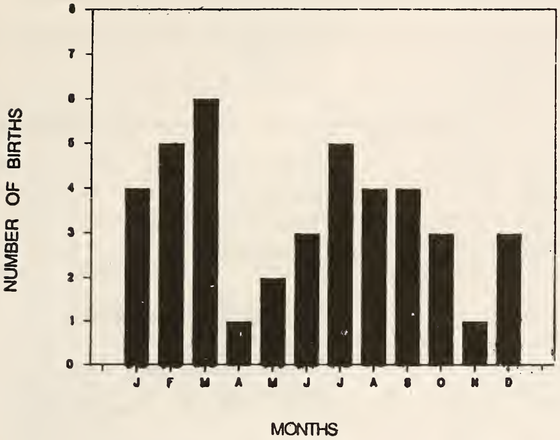

Fig. 3. Births observed in 3 troops (KI, KII and B) of Hanuman langur, which suffered infanticide during 1982-85.

lowest in November (Fig. 2).

In addition to this, nine bisexual troops (two multi-male and seven one-male troops) were followed in 1984 to record births and to investigate birth peak if any. Of 82 birth records, 48 were males and 34 were females. Births occurred in all the months in 1984. Although there was no distinct birth peak, fluctuations in the number of infants born in different months were observed. The concentration of births in January and February was evident compared to March and April, when fewer births were recorded. But in June and September there was again an increase in births while November was the lean month with minimum births. Likewise, August, May and December also had less births (Fig. 3).

Maturity: The onset of first menstruation was observed in two females at the age of 29.5 and 26 months and these females delivered their first infant after 5 and 7.7 months respectively. The first conception was estimated for five females at a mean age of 33.9 ± 3.2 months (range 30.3 to 37.2 months).

Menstruation: The successive menstrual bleeding in 35 cases for 10 females were recorded; it ranged from 16 to 31 days with an average of 24.8 ± 1.0 days. The bleeding lasted for 1-3 days (average 2 days) and in all cases blood flow was clearly visible.

Gestation: The time elapsed between last copulation and delivery of infant was calculated in 11 females and the gestation length ranged from 196 to 204 days (average 199.9 ± 3.0 days).

Birth interval: The time interval between two subsequent births was recorded for 24 cases in 18 females, whose infants were still alive when their younger siblings were conceived and born. This regular or normal birth interval ranged from 12.3 to 22.3 months and averaged 15.7± 2.4 months. The birth interval of females who lost their unweaned infants in eight cases ranged from 7.3 to 15.5 months, average 10.5 ± 2.9 months. It is significantly shorter than the normal birth interval (Mann-Whitney U Test, $P < 0.001$).

Troop Development

Considerable fluctuations in troop size and troop development were observed in the focal troops within the study period, mainly caused by births, deaths and disappearances of infants, juveniles and adults. After an extended process of male replacement and infanticide in troop KII, the troop structure changed considerably from 25 to 19 individuals (Table 3). In troop B, drastic changes in troop size from 21 to nine individuals was observed after male takeover (Table 4).

In both troops, infanticide was the major cause for infant and juvenile mortality. After the new males were established as leaders, both troops KII and B showed distinct increase in troop composition. In troop KI, there was not much fluctuation in the troop size since the troop did not suffer infanticide (Table 2). Details on the process of male replacement and social changes have been published elsewhere (Agoramoorthy 1987, Agoramoorthy and Mohnot 1988, Agoramoorthy *et al.* 1988).

Discussion

Although a few cases of diurnal births have been reported in Hanuman langur (McKenna 1974, Oppenheimer 1976), most of the births occurred at night. Many species of Cebidae and

TABLE 1
COMPARISON OF FIELD AND LABORATORY DATA ON FEMALE REPRODUCTIVE PARAMETERS OF *Presbytis entellus*

Female reproductive parameter	Published results	Field (F)/ Laboratory (L)	Source
Maturation			
Age at menarche	28.2 m	Jodhpur (F)	Winkler *et al.* 1984
	27.8 m	Jodhpur (F)	Present study
Age at first conception	34.2 m	Jodhpur (F)	Winkler *et al.* 1984
	36.4 ± 6.7 m	Jodhpur (F)	Present study
Menstruation			
Length of menstrual cycles	26.8 ± 1.0 d	Jaipur (L)	David & Ramasamy 1969
	28 d	Mount Abu (F)	Hrdy 1977
	24.1± 3.8 d	Jodhpur (F)	Winkler *et al.* 1984
	24.8 ± 1.0 d	Jodhpur (F)	Present study
Gestation			
Length of gestation period	172 d	Jaipur (L)	David & Ramasamy 1969
	200 ± 10 d	Davis (L)	Neurater (pers. comm.)
	6-7 m	Dharwar (F)	Sugiyama 1967
	200 ± 10 d	Mount Abu (F)	Hrdy 1974
	200.1 d	Jodhpur (F)	Winkler *et al.* 1984
	199.9 ± 3.0 d	Jodhpur (F)	Present study
Interbirth Interval			
Birth interval in normal cases	20-24 m	Dharwar (F)	Sugiyama 1967
	20-30 m	Mount Abu (F)	Cited in Harley 1985
	15.3 m	Jodhpur (F)	Winkler *et al.* 1984
	15.9 m	Berkeley (L)	Harley 1985
	15.7 ± 2.4 m	Jodhpur (F)	Present study
Birth interval in cases of infant loss	25-27 m	Dharwar (F)	Sugiyama 1967
	24 m	Mount Abu (F)	Hrdy 1977
	11.6 m	Jodhpur (F)	Winkler *et al.* 1984
	10.8 m	Berkeley (L)	Harley 1985
	10.5 ± 2.9 m	Jodhpur (F)	Present study

d = day, m = month

Cercopithidae tend to give birth at night (Jolly 1972). This would serve two functions (Bowden *et al.* 1967). First, the mother monkey has to move with the troop during the day in order to protect herself and if she is in the process of parturition, she will risk accidental predation by large carnivores in that area.

Second, in many species, adults are attracted and fascinated by new born infants and especially in Hanuman langurs, allo- mothering is very common, so it is presumably advantageous for langur females to deliver at night in order to safeguard their infants from inexperienced allo-mother interruption immediately after birth, who could damage the new born.

In the Himalayan population of langurs, distinct birth seasons occur. Births are spaced every 20-24 months and the seasonal breeding characters appear to be influenced by the high altitude habitat (Bishop 1979). In the non-Himalayan Hanuman langur population, births occur throughout the year without any seasonality but sometimes with clear birth peaks (Prakash 1962, Jay 1965, Sugiyama 1965, Hrdy 1977, Roonwal and Mohnot 1977, Bishop 1979).

However, there are always some out-of-season exceptions, and when coupled with small sample sizes these exceptions make the existence

TABLE 2
CHANGES IN THE GROUP COMPOSITION OF TROOP KI DURING JULY 1983-JUNE 1985

Date	Category & Sex		Langur I.D. No.	Event	Gain/ Loss	Troop Size
6 July '83	I	F	4.4.1	New birth	+ 1	18
7 Aug. '83	I	F	6.3.1	New birth	+ 1	19
23 Aug. '83	I	M	4.6	New birth	+ 1	20
9 Sep. '83	I	M	2.3.1	New birth	+ 1	21
? Sep. '83	A	F	9	Disappeared	− 1	20
23 Oct. '83	I	M	12.2	New birth	+ 1	21
13 Jun. '84	I	F	2.3.1	Died of electrocution	− 1	20
14 Jun. '84	A	F	8	Disappeared	− 1	19
25 Jul. '84	I	M	7.6	New birth	+ 1	20
24 Oct. '84	I	F	4.4.1	Disappeared	− 1	19
20 Jan. '85	I	M	6.3.2	New birth	+ 1	20
09 Feb. '85	I	F	4.4.2	New birth	+ 1	21
16 Mar. '85	I	F	3.2.1	New birth	+ 1	22
25 Mar. '85	I	M	12.3	New birth	+ 1	23
29 Mar. '85	I	M	7.6	Disappeared	− 1	22
08 Apr. '85	I	M	12.3	Died (reason not known)	− 1	21
08 Jun. '85	I	F	4.7	New birth	+ 1	22

A = Adult, I = Infant, M = Male, F = Female.
Group composition as on 1 July 1983 = 17 individuals.

of a real birth season questionable (cited in Moore 1985). There was no distinct birth peak for the nine troops which did not undergo male takeovers during 1984 and births were recorded throughout the year (Fig. 2). In contrast, the birth peak is convincing for the focal troops (Fig. 3). Here the sudden increase in number of births during February-March and July-September was a result of male replacements followed by infanticide in troops KII and B.

In Hanuman langurs, although the male juveniles started to wean from 14 to 18 months (Mohnot *et al.* 1987), the process of male maturity was difficult to observe, since male juveniles leave the natal troops during male replacements (Agoramoorthy 1987). The first menstrual cycle was observed in two cases and conception after 4-6 estrous cycles. In females who produced one or more infants, the conception normally occurred after two estrous cycles after postpartum. It appears that langur females reach their initial sexual maturity at the age of 2.5 to 3 years around Jodhpur. The mean age of females at first conception was estimated for six females as 36.4 months (Table 1).

Although in some study sites the flow of menstrual bleeding was not always detectable (Hrdy 1977, Jay 1965), in 35 subsequent menstrual cycles observed in 10 females in this study, the menstrual bleeding was clearly visible and the bleeding on average lasted for two days. The mean cycle length in the present study was 24.8 ± 1.0 days, which is closer to Winkler *et al.* (1984) (24.1 days) and David and Ramasami (1969) (26.8 ± 1.0 days) for captive colony langurs at Jaipur (Table 1). However, at Mount Abu, the average cycle length was 28 days (Hrdy 1977).

The normal birth interval of females whose infants survived at least for nine months averaged 15.7 months, which is closer to 15.4 months obtained from captive colony of langurs at Berkeley (Harley 1985). But the interval varied from 20-24 months for langurs of Dharwad (Sugiyama 1967) and 20 to 30 months for langurs of Mount Abu (Hrdy 1977, cited in Harley 1985). Six out of eight females that lost their unweaned infants under six months of age, conceived within two estrous periods after losing their infants, which is similar to the reports of Harley (1985). These six females started to deliver infants after 6.8 to 8.3 months

TABLE 3
CHANGES IN THE GROUP COMPOSITION OF TROOP KII DURING AUGUST 1983- SEPTEMBER 1985

Date	Category & Sex		Langur I.D. No.	Event	Gain/ Loss	Troop Size
23 Aug. '83	I	M	6.1	Attacked by invading male; infant disappeared next day	–1	24
12 Oct. '83	I	F	3.1	Attacked by invading band males, infant later disappeared	–1	23
15 Oct. '83	J	F	?	Died, reason not known	–1	22
20 Nov. '83	J	M	9.1	Attacked by invading male, later joined band (M 10)	–1	21
10 Dec. '83	I	F	?	Disappeared	–1	20
? Jan. '84	I	M	10.1	Disappeared, suspected infanticidal episode	–1	19
23 Feb. '84	I	F	5.1	New birth	+1	20
18 Mar. '84	I	M	4.2	New birth	+1	21
02 Apr. '84	I	F	5.1	Infanticide	–1	20
04 May '84	I	M	12.2	New birth	+1	21
11 May '84	I	M	12.2	Infanticide	–1	20
26 May '84	J	F	8.1	Died of electrocution	–1	19
06 Jun. '84	I	M	4.2	Infanticide	–1	18
11 Jun. '84	I	M	6.2	New birth	+1	19
16 Jun. '84	J	F	?	Died; dysentery and loss of body weight	–1	18
17 Jun. '84	I	M	6.2	Infanticide	–1	17
19 Jun. '84	I	M	9.2	New birth	+1	18
27 Jul. '84	I	M	1.1	New birth	+1	19
01 Aug. '84	I	M	11.2	New birth	+1	20
31 Aug. '84	I	M	10.2	New birth	+1	21
07 Sep. '84	I	F	7.1	New birth	+1	22
15 Sep. '84	I	F	8.2	New birth	+1	23
10 Nov. '84	I	M	5.2	New birth	+1	24
20 Dec. '84	I	M	12.3	New birth	+1	25
08 Jan. '85	I	M	4.3	New birth	+1	26
29 Apr. '85	I	M	4.1.1	New birth	+1	27
10 Aug. '85	I	M	11.3	New birth	+1	28
25 Aug.'85	I	F	8.2	Died of electrocution	–1	27
26 Sep. '85	I	F	6.3	New birth	+1	28

J = Juvenile, I = Infant, M = Male, F = Female.
Group composition as on 1 Aug. 1983 = 25 individuals.

and the birth interval averaged nine months, which is very close to the birth interval of females who suffered abortion and still birth at Berkeley colony (Harley 1985, p. 232).

In the remaining two females, who were older (approximately 12 years), conception took place after four and nine months respectively. The female who lost the youngest infant had the longest birth interval of 15.5 months. In particular, this female lost her second infant subsequently in infanticide, which appeared to be the reason. Does older age play a key role in lengthening birth interval in females who lose infants ? Do females adopt any strategy to prolong the birth interval in order to avoid losing their infant in infanticide? More data are required to test this hypothesis.

Comparing the age of infant at death or disappearance, with the duration of birth interval in females who lose their infants, after excluding the extreme two cases, a positive correlation was

TABLE 4
CHANGES IN THE GROUP COMPOSITION OF TROOP B DURING JANUARY 1983 - JULY 1985

Date	Category & Sex		Langur I.D. No.	Event	Gain/ Loss	Troop Size
12 Jan. '83	J	M	7.3	Disappeared	–1	20
17 Jan. '83	A	M	M. Star	Attacked and killed by invading males	–1	19
17 Jan. '83	A	F	3	Died, reason not known	–1	18
17 Jan. '83	A	M	M 38	Joined as new leader	+1	19
18 Jan. '83	J	M	3.5	Disappeared	–1	18
18 Jan. '83	J	M	Cripple	Disappeared	–1	17
18 Jan. '83	J	F	?	Disappeared after new male takeover	–1	16
30 Jan. '83	J	F	7.4	Died due to infection from bite wounds	–1	15
01 Feb. '83	A	F	7	Died; intestinal parasite *Strongyloides* sp. found during examination	–1	14
03 Feb. '83	I	M	5.4	Infanticide	–1	13
09 Feb. '83	I	F	6.5	Infanticide	–1	12
11 Feb. '83	I	M	1.5	Infanticide	–1	11
11 Feb. '83	A	F	5	Isolation, starvation and eventual disappearance after she lost her infant	–1	10
13 Feb. '83	A	F	9	Dog predation	–1	09
07 Oct. '83	I	M	1.6	New birth	+1	10
22 Oct. '83	I	M	1.6	Disappeared, reason not known	–1	09
23 Dec. '83	I	F	6.6	New birth	+1	10
25 Jan. '84	I	M	2.7	New birth	+1	11
20 Feb. '84	I	M	6.1.3	New birth	+1	12
29 Feb. '84	I	M	2.4.1	New birth	+1	13
02 July '84	I	M	1.7	New birth	+1	14
08 Mar. '85	I	M	6.7	New birth	+1	15
23 Mar. '85	I	M	6.1.4	New birth	+1	16
01 Jul. '85	I	F	6.4.1	New birth	+1	17

A = Adult, J = Juvenile, I = Infant, M = Male, F = Female.
Group composition as on 1 Jan. 1983 = 21 individuals.

found (Fig. 4). This indicates that the dominant male langur, who newly takes over a bisexual troop, will gain reproductive advantage if he successfully kills unweaned infants under six months of age (supposedly unrelated), in order to bring the mother into early estrous to sire his own offspring. He can thus increase his inclusive fitness (Trivers 1972, Hrdy 1977). But this advantage may vary depending upon the biological condition of the females.

Drastic decline in troop size was observed in troops B and KII as a result of male takeovers and infanticide. The highest infant mortality (87.5%) was observed in troop KII. In addition, three juveniles (two males and one female) disappeared in troop B after male change. But in one case, a male juvenile of troop KII was attacked and later joined a neighbouring band of males. This indicates that juvenile stage in males is critical since they are forced to leave their natal troop during male takeovers and have to face a new life with the bachelor males. But whether the reason for the disappearance of a female juvenile was due to emigration, predation, or other causes, is unknown.

It is evident that the male replacements strongly influenced troop structural changes in Hanuman langurs of Jodhpur. This is similar to

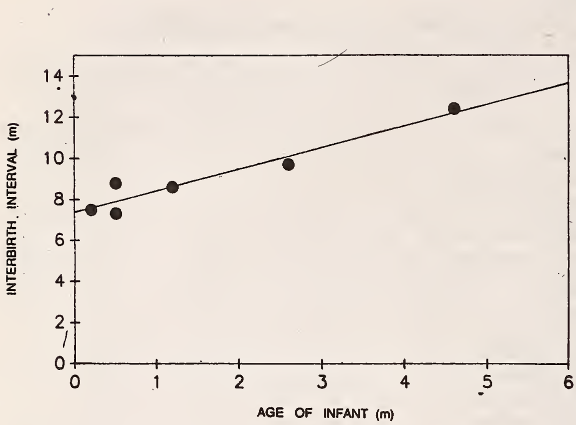

Fig. 4. A positive correlation between the age of infants at death and duration of interbirth interval in Hanuman langurs of Jodhpur.

the phenomenon in purplefaced langurs *Presbytis senex* and in lions *Panthera leo*, where increased infant mortality during male takeovers has been reported (Rudran 1973, Bertram 1975, Packer and Pusey 1983).

Langurs around Jodhpur appear to reach maturity about one year earlier than at other study sites like Dharwar and Mount Abu (Vogel and Loch 1984), and in addition the interbirth interval is comparatively shorter (Table 1). However, Harley (1985) compared the langur reproductive data of Jodhpur to the langurs of Mount Abu and Dharwar and argued that Mount Abu and Dharwar results were overestimated since these data did not result from long-term observations like Jodhpur, so inaccuracy on langur parturition and undetected loss of pregnancy or neonate seemed to be the cause for overestimation.

It is clear that the long-term langur reproductive data from Jodhpur and Berkeley colony are similar. Here, I must mention that Jodhpur habitat is semi-desert and natural food appears to be scarce (Agoramoorthy 1987). In addition, artificial food is common to all langur troops around Jodhpur. But, how far the artificial provisioning will affect the birth interval in langurs of Jodhpur is not clear. Studies on Japanese macaques showed that artificial food reduced birth interval in females (Sugiyama and Ohsawa 1985). More detailed and longer-term data are needed from other study sites such as Dharwar and Mount Abu to better examine the effect of artificial food in shortening birth interval in langurs, and also to note the difference in reproductive parameters within the species *Presbytis entellus* itself.

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NEW DESCRIPTIONS

FIRST RECORD OF THE GENUS *LAURENTINA* MALAISE (HYMENOPTERA : TENTHREDINIDAE) FROM INDIA, WITH DESCRIPTION OF A NEW SPECIES[1]

MALKIAT S. SAINI AND DEVINDER SINGH[2]

(With two text-figures)

Two species of *Laurentina* Malaise, viz. *L. birmanica* Malaise, 1937 and *L. sarchuckensis* sp. nov. are recorded from India. In addition to a key to the so far known species of this genus, female lancets of the Indian species are illustrated.

INTRODUCTION

Based on three species from Burma, Malaise (1937) proposed *Laurentina* as a subgenus of *Laurentia*. In a succeeding comprehensive work (Malaise 1945) he raised it to the generic level with the following combination of characters: anterior margin of clypeus truncate, hind femur shorter than tibia and reaching apex of abdomen, mesopleuron minutely rugose with sebaceous lustre, scutellar appendage polished and the anal cell with a short cross vein placed in the basal half.

Takeuchi (1952) in his work on Japanese genera of Tenthredinidae, synonimised this genus with *Aglaostigma*. However, we feel that as the species of the genus *Laurentina* possess a hind femur that reaches the tip of the abdomen, a character missing in *Aglaostigma, Laurentina* should be retained as a distinct genus as characterised by Malaise (1945).

In the present studies two species of this genus are recorded from the eastern Himalayas. One of the species is *L. birmanica* Malaise while the other is new. Apart from describing the new species, the detailed description of *L. birmanica* has been rewritten as the available account is insufficient. The holotype of *L. sarchuckensis* sp. nov. will be deposited with the Pusa National Collection, IARI, New Delhi. Regd. No. L-157/RIT.

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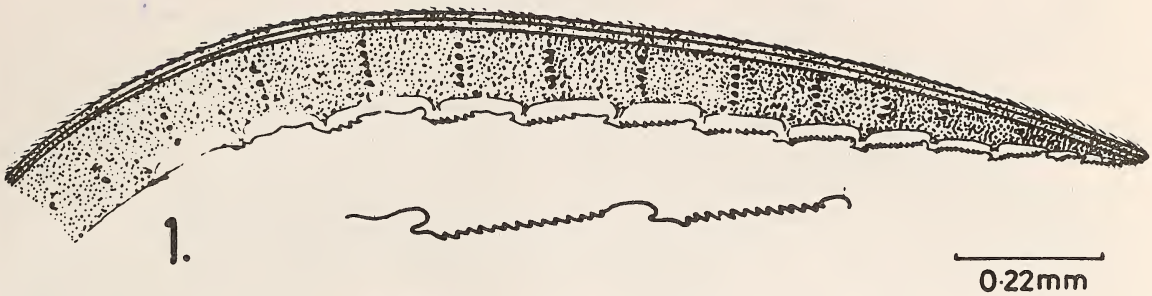
Abbreviations: EL – eye length; IDMO – interocular distance at level of median ocellus; LID – lower interocular distance; OCL – ocello-occipital line; OOL – oculo-ocellar line; POL – post-ocellar line.

Laurentina sarchuckensis sp. nov.

FEMALE: Length, 8.6 mm. Body black. Labrum, lateral spot on clypeus, medial spot on supra-clypeal area, small spot at tip of supra-antennal tubercle, narrow stripe along inner orbit, stripe on hind orbit, narrow posterior margin of pronotum, spot on tegula and metepimeron yellowish brown. Legs reddish brown. Coxae, trochanters, extreme bases of femora and apex of hind tibia black. Wings yellowish, hyaline, stigma and venation brown, costa fulvous.

Antenna 2.8x head width, segments 3 and 4 in ratio 7:6. Labrum broader than long with roundly pointed anterior margin. Malar space equal to diameter of median ocellus. LID:IDMO:EL = 2.0:2.6:1.5. OOL:POL:OCL = 2.7:1.0:1.5. Frontal area at level of eyes. Supra-antennal tubercle raised and merging with low frontal ridge. Median fovea like a broad depression, not reaching median ocellus. Circumocellar furrow deep, long and obliquely cutting across frontal ridge. Inter- and post-ocellar furrows sharp. Lateral furrows broad and sunken. Postocellar area flat, broader than long in ratio 2:1. Head narrowing behind eyes. Mesoscutellum flat. Appendage faintly carinate. Seams of mesonotum fine and not sunken. Subapical tooth of claw stronger and subequal to apical one.



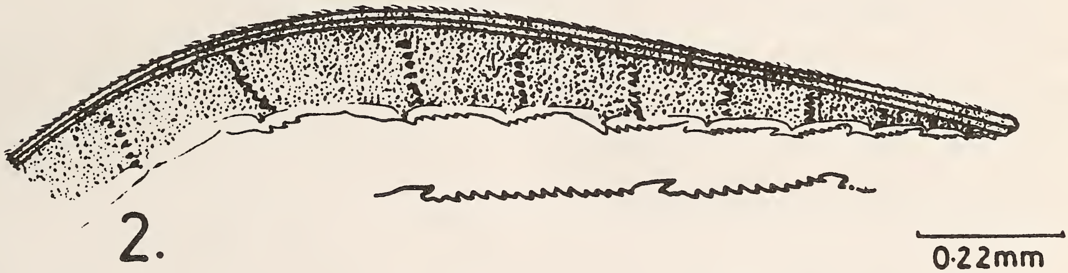


Fig. 1. Lancet of *L. sarchuckensis* sp. nov.

Fig. 2. Lancet of *L. birmanica* Malaise.

Metabasitarsus shorter than following tarsal joints combined.

Head rugose, hind orbit strongly microsculptured with scattered but distinct punctures. Mesonotum miscrosculptured with deep punctures along seams. Mesoscutellum with deep and distinct punctures on posterior slope only. Abdomen microstriated. Lancet as in Fig. 1.

Holotype: Female, Sikkim, Sarchuck, 2400 m. 22 May 1988.

The new species is closely related to *L. unicincta* Malaise, 1937, but can easily be distinguished from the latter as shown in the key.

Etymology: The species name has been taken from the type locality.

Laurentina birmanica Malaise

FEMALE: Length 9.0 mm. Body black. Labrum, small lateral spot on clypeus, medial spot on supraclypeal area, narrow stripe along inner orbit continuous over temple and curving downwards along hind orbit without touching eye, narrow margin of pronotum, appendage of metepimeron, small outer spot on meso- and metacoxae white. Abdomen beyond segment 2 except sawsheath, pro- and mesolegs except coxae, trochanters and extreme bases of femora, metaleg except coxa reddish brown. Wings clear, front one yellowish hyaline, stigma and venation brown.

Antenna 2.7x head width, segments 3 and 4 in ratio 7:6. Labrum broader than long with roundly pointed anterior margin. Malar space 1.2x diameter of median ocellus. LID:IDMO:EL = 2.0:2.4:1.5. OOL:POL:OCL = 3.1:1.0:2.0. Frontal area elevated above level of eyes. Supra-antennal tubercle raised and confluent with frontal ridge. Median fovea narrow, ditch-like,

hardly reaching median ocellus. Circum-, inter- and post ocellar furrows clear. Lateral furrows excurved and sunken. Postocellar area flat, broader than long in ratio 2:1 with deep median longitudinal furrow. Head parallel behind eyes. Mesoscutellum hardly raised. Appendage with sharp carina. Seams of mesonotum broad and sunken. Subapical tooth of claw stronger and slightly longer than apical one. Metabasitarsus shorter than following tarsal joints combined.

Head appearing wrinkled due to large, shallow and confluent punctures, hind orbit minutely and densely punctured. Mesonotum minutely punctured with strong microsculpture at apex of middle lobe. Mesoscutellum with distinct punctures on posterior slope. Appendage polished. Mesepisternum strongly wrinkled. Mesosternum minutely and densely punctured. Appendage of metepisternum polished. Abdomen microstriated, propodeum more strongly so. Lancet as in Fig. 2.

Material examined: 3 females, Arunachal Pradesh, Bomdila, 2700 m, 1 May 1989.

KEY TO THE KNOWN SPECIES OF *Laurentina* MALAISE

1. Hind wing with one closed middle cell in female. Mesonotum shining with scattered minute punctures. Seams of mesonotum broad and sunken. Lancet as in Fig. 2 .... *L. birmanica* Malaise
— Hind-wing with two closed middle cells in female. Mesonotum densely punctured or microsculptured. Seams of mesonotum fine and not sunken 2
2. General colour reddish with few black markings. Head dilated behind eyes in female ... *L. ruficornis* Malaise
— General colour black with few reddish markings. Head narrowing behind eyes 3
3. Tergum 4 pale yellow. Postocellar area subconvex. Subapical tooth of claw longer than apical one .... *L. unicincta* Malaise
— Abdomen entirely black. Postocellar area flat. Subapical tooth of claw shorter than apical one. Lancet as in Fig. 1 .... *L. sarchuckensis* sp. nov.

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OSTEOBRAMA BHIMENSIS, A NEW CYPRINID FISH FROM BHIMA RIVER, PUNE DISTRICT, MAHARASHTRA[1]

D.F. SINGH AND G.M. YAZDANI[2]

(*With two text-figures*)

A few specimens of the Indo-Burmese genus *Osteobrama* Heckel were collected from the reservoir at Ujani on the river Bhima about 98 km from Pune. These proved on examination and detailed comparison with the related species, *Osteobrama cotio* (Ham.), to be a new species which is described here.

Day (1889) recorded seven species under the genus *Rohtee* from the Indian subcontinent, namely *R. bakeri* Day, *R. neilli*, *R. cotio* (Ham.), *R. vigorsii* Sykes, *R. belangeri* (Cuv. & Val.), *R. ogilbii* Sykes and *R. cunma* (Tickell). Of these, only *R. ogilbii* is now retained under *Rohtee* whereas the rest are now assigned to *Osteobrama*. Among them, *O. cotio*, a widely distributed species is known by two subspecies viz., *O. cotio cotio* (Ham.) from north India and Assam and *O. cotio cunma* (Day) from Burma and Pune (Jayaram 1981).

Bhima, the major river of Pune district, is an important tributary of the Krishna river system. A dam constructed on the river at Ujani has given rise

[1]Accepted July 1991.

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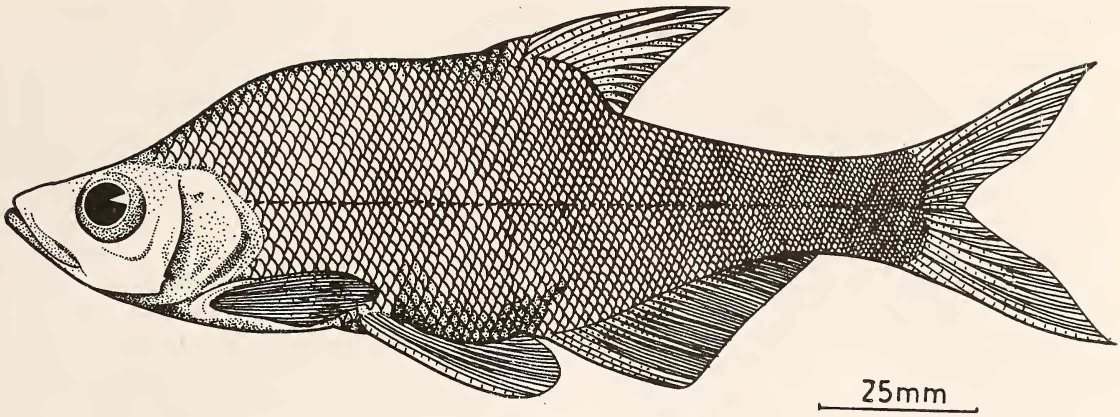

Fig. 1. *Osteobrama bhimensis* sp. nov.

to a large reservoir which is now declared as a "wetland of national importance". Faunistic surveys of this wetland are being undertaken regularly by the Zoological Survey of India, Western Regional Station, Pune for studying the faunal composition in relation to ecological parameters.

Osteobrama bhimensis sp. nov.

Description (Fig 1) : D iii-iv 9, P i/15; V i/9, A iii/23-25, C 19, LL 76-83.

Body short, deep and compressed. Abdominal edge keeled only between pelvic and anal fins. Dorsal profile arched just over the nape. Head length 3.68 (3.4-3.9), body depth 3.28 (3.0-4.1) in standard length respectively. Snout 3.28 (3.0-3.8), eye 3.25 (2.5-3.8) and interorbital width 3.88 (3.6-4.2) in head length. Eye 1.06 (0.83-1.2) in snout length and 1.01 (0.83-1.3) in interorbital width. Eyes large and just visible from below the ventral surface of head. Upper jaw slightly longer than the lower. Lips thin and plain. Barbels absent. Rayed dorsal fin inserted nearer caudal base than tip of snout. The ventral fin extends beyond anal opening. Predorsal length 1.73 (1.7-1.8) while postdorsal length 2.0 (2.0-2.1). Dorsal fin with a strong serrated spine. Caudal fin deeply forked. Scales well formed. Lateral line with 79 scales (76-83). 13-17 scales between pelvic fin base and LL and 28 (24-32) predorsal scales.

Uniform silvery colour with dark along the

TABLE 1

MORPHOMETRIC MEASUREMENTS OF *O. bhimensis* SP. NOV.

Proportions	Range	Mean	Range (in %)	Mean (in %)
Total length (TL)/Standard length (SL)	1.22 - 1.29	1.25	77.20 - 81.81	79.56
SL/head length	3.4 - 3.9	3.68	25.14 - 29.16	27.0
SL/body depth	3.0 - 4.1	3.28	24.30 - 32.85	30.5
SL/predorsal length	1.7 - 1.8	1.73	55.55 - 59.31	57.5
SL/postdorsal length	2.0 - 2.1	2.0	44.44 - 50.47	48.3
Body depth/head length	1.13 - 1.23	1.19	80.76 - 87.80	83.7
Head length/snout length	3.0 - 3.8	3.28	26.31 - 33.33	30.7
Head length/eye diameter	2.5 - 3.8	3.25	26.19 - 31.57	29.0
Head length/inter orbital width	3.6 - 4.2	3.88	20.28 - 27.77	24.9
Snout/eye diameter	0.83 - 1.2	1.06	83.33 - 120	95.4
IOW/eye diameter	0.83 - 1.3	1.01	76.92 - 120	100.8
Preanal length/SL	1.6 - 1.7	1.63	58.8 - 62.06	60.3

back. Further data is presented in Table 1.

Distribution: River Bhima, Pune district, Maharashtra.

Type specimens: Holotype — River Bhima, Saha village, Indapur taluka, Pune district, Maharashtra. 6 Sept. 1989, 135 mm SL. Coll. D.F. Singh. Reg. No. P/1235.

Paratypes — 5 exs. 137-210 mm SL. Reg. No. P/1236 with same details as above.

The type material will later on be deposited in the National Zoological Collection at Calcutta. Presently it is kept in the Western Regional Station of ZSI, Pune.

Hora and Misra (1940) in their revisionary work on fishes under the genus *Rohtee* (=*Osteobrama*) recorded the occurrence of *Osteobrama cotio* (Ham.) from north India and Assam and its variety [*O. c. cunma* (Day)] from Burma and Pune. Jayaram (1981) however, recognised two subspecies *O. cotio cotio* and *O. cotio cunma*. However, no specimen of the subspecies *cunma* has been obtained by us anywhere in Pune district.

While comparing the morphometric and meristic characters of the new species with the two known subspecies, it was seen that there is a clear difference in the number of lateral line scales, lateral transverse, branched rays in the anal fin, predorsal scales, among other characters. The differences have been shown in Table 2. This new species shows a striking resemblance to *O. vigorsii* which also occurs in Bhima river, but differs in the following characters: absence of barbels, number of transverse scales, etc. (Table 2).

To further confirm our findings, the urohyal bones of *O. bhimensis* and *O. vigorsii* were studied. This bone, which lies in the lower part of the head between the lower jaw bones, has proved to be of exceptional significance in fish systematics.

The urohyal in both species is long and slender. In *O. bhimensis* the dorsal spread is long with its posterior right side thickened while its left side is slender and tapering (Fig. 2). In *O. vigorsii*, the dorsal spread ends posteriorly in two unequal wings, the left side being longer and thickened. The vertical plate too shows structural variations in the two species. *O. vigorsii* has a radial process on its vertical plate which is lacking in *O. bhimensis*.

TABLE 2

MORPHOMETRIC AND MERISTIC CHARACTERS OF *O. bhimensis* SP. NOV., *O.c.cunma*, *O.c.cotio* AND *O.vigorsii*

Characters	*O.bhimensis*		*O. c. cunma* *		*O. c. cotio* *		*O. vigorsii* *	
	Range	Average	Range	Average	Range	Average	Range	Average
Standard length/ head length	25.14 - 29.16	27.4	21.83 - 27.38	24.35	22.72 -28.57	24.71	25 - 28.78	27.4
Standard length/ body depth	24.30 - 32.85	30.52	33.33 - 48.92	41.74	37.14 - 48.30	42.07	34.16 - 39.13	35.98
Body depth/ head length	80.76 - 87.80	83.72	47.36 - 80	58.83	49.56 - 66.66	58.99	69.44 - 80.43	75.22
Head length/ snout length	26.31 - 33.33	30.70	23.07 - 31.81	28.31	21.62 - 30.00	26.43	23.78 - 30	27.94
Head length/ eye diameter	26.19 - 31.57	29.04	35.61 - 47.77	39.97	36.66 - 45.00	42.05	26.66 - 35.5	31.52
Head length/ interorbital width	20.28 - 27.77	24.99	21.05 - 31.61	27.18	22.63 - 32.00	27.54	16.66 - 22.4	19.49
Lateral line scales	76 - 83	79	42 - 60	49	58 - 70	62	73 - 85	78
Scales between LL and Pelvic fin	13 -17	14	7.5-9.5	8	10.5-13	11	11 - 11.5	11
Predorsal scales	24 - 32	28	18 - 24	21	24 - 29	26	33 - 37	34
Anal fin	3/23-25	3/24	3/25-31	3/28	3/28-33	3/30	3/21-27	3/23
Barbels		Absent		Absent		Absent	Two rudimentary maxillary barbels.	

* Measurements calculated from Hora & Misra (1940). All ratios are expressed as percentages.

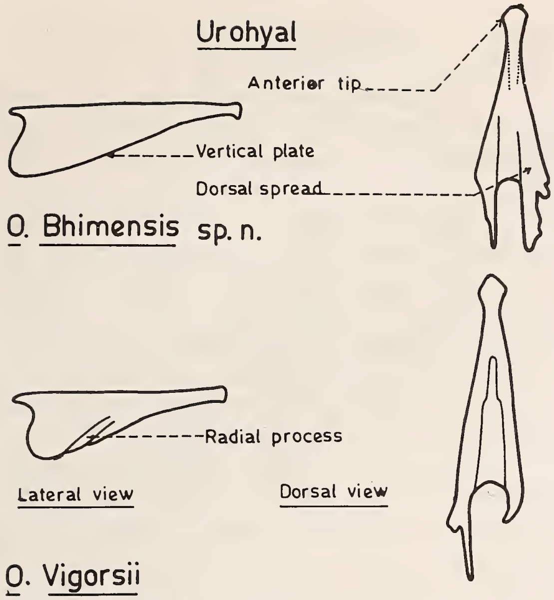

Fig. 2. Urohyal in *O. bhimensis* and *O. vigorsii*.

KEY TO THE SPECIES (MODIFIED) FROM HORA & MISRA (1940)

1. Barbels absent 2
— Barbels present 4
2 Anal fin with less than 20 branched rays. Abdominal edge keeled throughout .... *O. belangeri*
— Anal fin with more than 20 branched rays. Abdominal edge keeled only between pelvic and anal fins 3
3. L.L. 42 - 60, scales between L.L. and pelvic fin 7-9.5, anal fin with 25 - 31 branched rays .... *O. cotio cunma*
— L.L. 58-70, scales between L.L and pelvic fin 10.5-13. Anal fin with 28-33 branched rays . *O. cotio cotio*
— L.L. 76-83, scales between L. L. and pelvic fin 13-17, anal fin with 23-25 branched rays .... *O. bhimensis* sp. nov.
4. Four well defined barbels 5
— Two rudimentary maxillary barbels only 7
5. Anal fin with more than 20 branched rays. L.L.scales more than 60 .... *O. feae*
— Anal fin with less than 20 rays. L.L. scales less than 60 6
6. L.L. scales 59, 17 branched rays in anal fin . . *O. neilli*
— L.L. scales 44, 11 branched rays in anal fin *O. bakeri*
7. L.L. scales 73-85. Anal fin with 21-27 branched rays .... *O. vigorsii*
— L.L. scales 86-70. Anal fin with 16-18 branched rays .... *O. dayi*

We thank the Director, Zoological Survey of India, Calcutta for allowing us to undertake this work, and Dr. R.S. Pillai, Joint Director, Z.S.I. Madras for critically going through the manuscript. We are also thankful to Dr. A.G.K. Menon, Emeritus Scientist, Z.S.I. Madras for his help and suggestions.

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FIRST REPORT OF THE FAMILY VAEJOVIDAE (SCORPIONIDAE : ARACHNIDA) IN MADHYA PRADESH, WITH THE DESCRIPTION OF A NEW SPECIES *SCORPIOPS (SCORPIOPS) PACHMARHICUS*[1]

Deshabhushan Bastawade[2]

(With eight text-figures)

Scorpions of the family Vaejovidae are known from 23 nominal species from Indian subcontinent (Tikader and Bastawade 1976, 1983). All known species have been described under the genus *Scorpiops* Peters 1861 by splitting up this genus into three sub-genera, namely *Scorpiops* Peters (typical), *Euscorpiops* Vachon

[1]Accepted September 1991.

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and *Neoscorpiops* Vachon. The first two sub-genera are widely distributed in the Himalaya from Kashmir to Arunachal Pradesh; while the third sub-genus is known to occur in a few areas in the Western Ghats, from Maharashtra and Gujarat (Fig. 1). This family remained unreported from Aravalli and Satpura ranges in central India; Western Ghats in Karnataka; Nilgiri, Anamalai, Cardamom and Nallamalai hills in southern India and also from Mahendra hills and Malayagiri in south-eastern India. The family requires revision (Francke 1976, Vachon 1973, 1980). A thorough exploration is also desirable throughout the central and southern parts of the country by scorpiologists to determine its distributional boundaries and to study speciation trend.

Recently some specimens of this family were collected from Pachmarhi (410 m above sea level), Madhya Pradesh for the first time. These specimens show close resemblance with a known species *Scorpiops (Scorpiops) montanus* Pocock in their general appearance. *S. (S.) montanus* Pocock is a widely distributed species in Western Himalaya and commonly occurs at Jaunsar, Kasauli and Dharmsala (type locality) in Punjab and Uttar Kashi, Tehri, Dehra Dun, Pauri, Almora and Nainital in Uttar Pradesh (Tikader and Bastawade 1983). There are no authentic records for the occurrence of this family between Nainital, Uttar Pradesh and Pachmarhi, Madhya Pradesh. Detailed study of the specimens collected from Pachmarhi suggest that they belong to a new species under the sub-genus *Scorpiops* Peters. This communication describes and illustrates the new species.

Scorpiops (Scorpiops) pachmarhicus sp. nov.
(Figs. 2-8)

General: Scorpions of small to medium body size, yellowish to brown in colour; chelicera darker on fingers; pedipalp dark brown and darker on carinae; legs yellowish; carapace, mesosoma and metasoma light brown except yellow telson; ventral portion yellowish, body surface almost entirely smooth, pectines poorly developed.

Measurements: Female (Holotype), total body length 34.50 mm; carapace 5.25 mm long, mesosoma 14.50 mm long; metasoma 15.75 mm long.

Carapace: Entirely smooth, without carinae, anterior median, posterior median and posterior lateral furrows distinct, margins smooth and anterior margin deeply incised; ocular tubercles poorly developed, smooth, a pair of median eyes anteriorly situated in the ratio 1 : 1.75 as in Fig. 2, three lateral eyes, anterior two larger than the remaining as in Fig. 3.

Mesosoma: Tergites I-VI almost entirely smooth, except weakly and much sparsely granular on posterior portions of tergites IV-VI; pretergal portion of each tergite including all margins smooth; tergite VII smooth, with two pairs of weakly granular carinae, present only on posterior portion, pretergal portion and margins smooth; sternites III-VII entirely smooth, presternal portions and margins smooth; sternites III-VI each provided with a pair of slit-like stigmata for book lungs.

Metasoma: Cauda three times as long as carapace; basal segment always wider than long, all ten carinae distinct and weakly crenulate; segments II-IV with eight carinae poorly granular to obsolete, dorsals ending posteriorly into weak spiniform tubercles, laterals present only on one third posterior portion of segments II and III, intercarinal portion almost smooth except weakly granular dorsal portion; segment V shorter than carapace, a pair of inferiors and a single inferior median carinae poorly granular, anal rim of this segment weakly and sparsely crenulate as in Fig. 4; telson longer than segment V but shorter than carapace; vesicle as long as segment IV and as wide as deep as segment V; smooth, setation as in Fig. 4; aculeus less than half the vesicular length, not much curved, reddish and sharply pointed as in Fig. 4.

Appendages: Chelicera small, basal segment smooth, brownish reticulation on dorsal

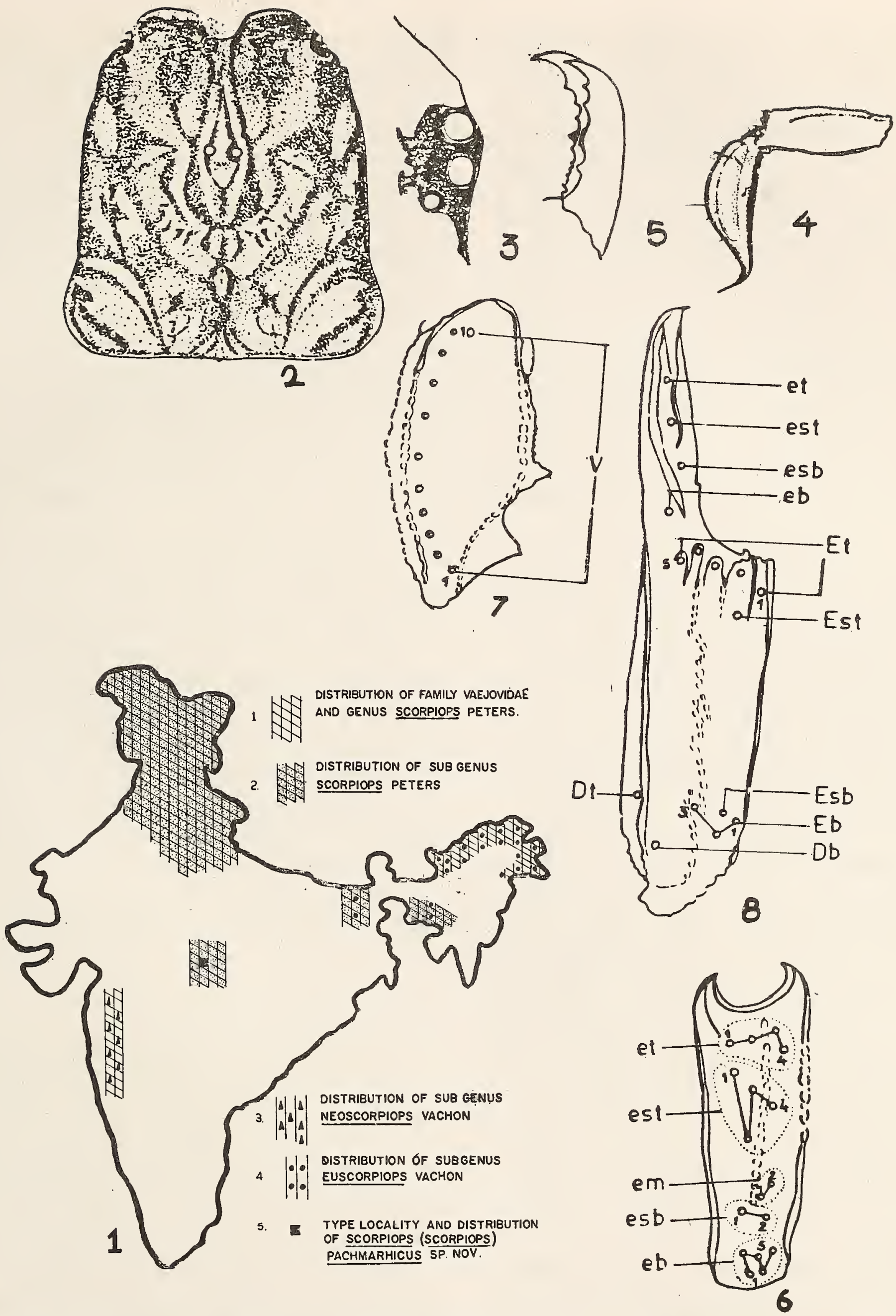

Fig. 1. Map of India, showing distribution of Family Vaejovidae and its genus and subgenera.

Figs. 2-8. *Scorpios (Scorpiops) pachmarhicus* sp. nov.

2. Dorsal view of carapace, 3. Lateral view of carapace, showing lateral eyes, 4. Interior view of movable finger of chelicera, 5. Lateral view of telson, 6. Exterior view of tibia, 7. Ventral view of tibia, 8. Dorso-exterior view of manus.

portion, fingers dark brown, toothed normally and inferior fang of moveable finger provided with 8-9 minute teeth on interior margin as in Fig. 5; distal tooth larger. Pedipalp stout and strong, not much flat, carinated; femur shorter than carapace, carinated, all four carinae granular but inner carinae much more sparsely granular, anterior or outer surface with two short tubercles; tibia as long as femur but shorter than carapace, carinated, posterior or outer carinae smooth and nearly obsolete, anterior or inner surface with three to four strong basal tubercles; manus flat, much larger than femur but as long as carapace, wider than femur as well as tibia, carinated and all carinae weakly granular on proximal portion and obsolete distally, inter-carinal space sparsely but coarsely granular on inner portion while finely granular on dorsal portion, fingers smooth, with few obsolete carinae, immovable finger shorter than femur but movable finger as long as tibia, dentition on fingers arranged in finely granular, double lined, supported with distinct patches of scars at intervals. Trichobothrial patterns on femur, tibia, manus and immovable finger typical for family, genus and sub-genus as in Figs. 6-8 but differ in the number of ventrals (10) on tibia as in Fig. 7. and some relative positions of Eb2 to Eb1 on tibia and Dt to Eb3 on manus as in Figs. 6 and 8. Legs I-IV almost entirely smooth except crenulated anterior carinae on femur, laterally flat, tarsomere II provided with a median line of minute spines, spine formula on leg I-VI : $^6/_6$, $^5/_6$, $^6/_8$, $^7/_8$. Genital operculum wider than long, sclerites fused medially in female while separated on posterior portion in male, a small genital papillae visible; pectines twice as long as wide, weakly developed, middle lamillae and falcra undistinguished, pectinal teeth 6/6 in female while 7/7 in male.

Material examined: Holotype 1 female, Paratype 2 females, Allotype 1 male mature; collected from Pachmarhi (410 m above sea level in Mahadev Hills of Satpura (22° 60' N, 78° 50' E), Madhya Pradesh. Collected by Dr. D.F. Singh, ZSI, WRS, Poona, August 1985 and October 1987. The type specimens have been deposited in the National Collection, Z.S.I. Calcutta.

This species closely resembles *Scorpiops (Scorpiops) montanus* Pocock (Tikader and Bastawade 1983) in appearance but differs from it as follows. (1) A pair of median eyes anteriorly situated in the ratio 1 : 1.75 whereas in *S. (S.) montanus* the ratio is 1 : 2. (2) Carapace and tergites almost entirely smooth whereas in *montanus* they are coarsely granular on lateral portions. (3) Inferior inner margin of movable finger of chelicera provided with 8-9 minute teeth whereas in *montanus* there are 6 teeth. (4) Metasomal segments II-IV with weakly granular and poorly spiniform dorsal carinae whereas in *montanus* dorsal carinae are strongly crenulate and spiniform posteriorly. (5) Ventral trichobothria number only 10 whereas in *montanus* they number 13 to 14 on tibia and external basal 2 (Eb2) trichobothria placed proximal to 1 as in Fig.6, whereas in *montanus* external basal (Eb1) placed proximal to 2 on tibia. (6) Dorsal terminal (Dt) trichobothria on manus placed distal to External basal 3 (Eb3) as in Fig. 8, whereas in *montanus* Dt placed proximal or in same line to Eb3 on manus.

This species is named after the locality from where the specimens were collected.

Acknowledgements

I wish to thank Prof. (Dr) M. S. Jairajpuri, Director, Zoological Survey of India, Calcutta, Dr. G.M. Yazdani, Scientist "SE" Officer-in-charge, Zoological Survey of India, Western Regional Station, Pune and P.T. Bhutia, Scientist "SD", Officer-in-charge, Zoological Survey of India, Arunachal Pradesh Field Station, Itanagar for providing me necessary facilities, constant encouragement during the work and suggesting improvements of the manuscript. I am grateful to Dr. D.F. Singh, for collecting the specimens and allowing me to study them at Pune.

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ON A NEW SPECIES OF *SINGHIUS* TAKAHASHI (ALEYRODIDAE: HOMOPTERA) WITH A KEY TO INDIAN SPECIES[1]

R. SUNDARARAJ AND B. V. DAVID[2]

(With a text-figure)

Takahashi (1932) erected *Singhius* as a subgenus under the genus *Dialeurodes* for the species *Aleyrodes hibisci* Kotinsky. In 1978 Mound and Halsey elevated it as a full genus. Alexander and David (1990) shifted the species *Aleurotuberculatus russellae* David and Subramaniam to *Singhius* and thereby suggested a new combination. In the present paper a new species is described under this genus from India. A key to the Indian species of *Singhius* is provided.

KEY TO INDIAN SPECIES OF *Singhius* TAKAHASHI

1. Dorsal setae short and capitate 2
— Dorsal setae long and with pointed tips .... *hibisci* (Kotinsky)
2. Pupal case 1.01-1.06 mm long 0.76-0.81 mm wide; margin with 25 crenulations in 0.1 mm; thoracic tracheal pore region slightly indicated; entire dorsum granulated ...... *russellae* (David & Subramaniam)
— Pupal case 0.79-0.95 mm long and 0.55-0.70 mm wide; margin with 20 crenulations in 0.1 mm; thoracic tracheal pore region distinct; subdorsum only granulated .... *morindae* sp. nov.

Singhius morindae sp. nov. (Fig. 1)

Pupal case: White with a little wax on dorsum; elliptical, broadest at the first abdominal segment region; found singly and scattered on the under surface of leaves; 0.79-0.95 mm long and 0.55-0.70 mm wide.

Margin: Regularly crenulate, 20 crenulations in 0.1 mm; anterior and posterior marginal setae 15μ and 25μ long respectively. Thoracic and caudal tracheal pores indicated.

Dorsal surface: Dorsal setae capitate, cephalic setae 17.5μ long, first abdominal setae (broken), eighth abdominal setae 5μ long, and caudal setae on either side of caudal pore 37.5μ long. Dorsum with sparsely distributed minute pores; subdorsum with semicircular markings. Submargin with suture-like lines running mesad from margin distinct. Submarginal or subdorsal setae absent.

Vasiform orifice: Subrectangular, wider than long (30-37.5μ x 45-55μ); operculum wider than long (15-20 x 30-35μ) towards caudal end constricted at half its length and somewhat rounded, filling the orifice; lingula concealed. Caudal tracheal furrow funnel-shaped with a constriction at the middle half and at the pore end and with minute irregular markings. Thoracic tracheal furrows not indicated.

Ventral surface: Ventral abdominal setae 17.5μ long and 32.5μ apart; caudal and thoracic

[1]Accepted June 1991.

[2]Fredrick Institute of Plant Protection and Toxicology, Padappai 601 301.

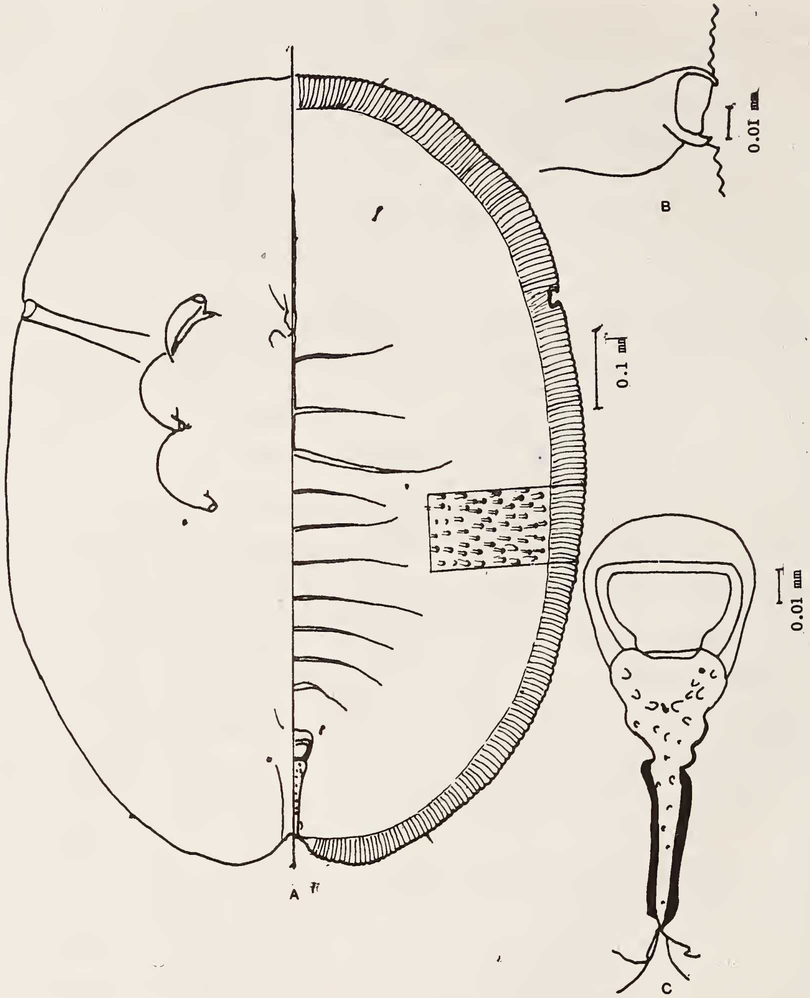

Fig. 1. *Singhius morindae* sp. nov. A. Pupal case, B. Margin, C. Vasiform orifice.

tracheal folds indicated but lack stipples or dots.

Material examined: *Holotype. Morinda tinctoria,* Vellimalai (Tamil Nadu), 3 Aug. 1987. Coll. R. Sundararaj. The holotype is with B.V. David.

Paratype: One mounted pupal case on slide, data same as for holotype, deposited in the collection of the Systematic Entomology Laboratory, USDA, Beltsville, Maryland, U.S.A.

This new species resembles *S. russellae* (David and Subramaniam) by the presence of capitate dorsal setae but differs in shape and by indication of thoracic tracheal pore region. It also resembles *S. hibisci* (Kotinsky) in shape and size but differs by capitate nature of dorsal setae.

Acknowledgements

We thank S. James Fredrick, Chairman and Dr. Clement Peter, Head, Division of Entomology, FIPPAT for facilities provided.

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A NEW SPECIES OF *LIPARIS* RICHARD (ORCHIDACEAE) FROM SIKKIM[1]

S. Z. LUCKSOM[2]

In my recent orchid survey in Bhusuk valley of Sikkim, I could collect many interesting orchids. A new species of *Liparis* Hook. f, collected during the exploration, is described.

Liparis lydiaii sp. nov.

Liparis platyrachis Hook. f., affinis, sed differt pseudobulbo 1-2 cm longus, coepitosus, ovaideo-cylindricus. Folia 4, graciliter membranacea, alterna, ovato-oblonga, 1-2.7 cm x 0.4 - 0.9 cm, ad marginem integra, ad superficies undulata. Inflorescentia 8-11.5 cm, terminalibus, subpendula, pedunculus 0.8-2.5 cm longus, gracilis, teretus, erectus, cum 2-3 bracteolis, cordatis, basi amplexicaulibus, 5-6 x 2-3 mm, racemus 8-9 cm longus, teretus, cum 4-14 floribus. Sepalum dorsale sepalis lateralibus majus, 3.6-4 x 2.6-3 mm, cordato-retroflexum. Labellum 2-2.5 x 0.8-1 mm, cordatum, ad medium parvum deflexum.

Liparis lydiaii sp. nov.

Epiphytic. Pseudobulb 1-2 cm long, tufted, ovoid-cylindric, sheathed, 3.5-6 mm diam., broader at the base and slightly tapering towards the apex. Leaves 4, 1-2.7 x 0.4-0.9 cm, thinly membranous, alternate, ovato-oblong, undulating leaf surface, margin entire. Inflorescence 8-11.5 cm, sub-pendulous. Peduncle 0.8-2.5 cm long, slender, terete, erect with 2-3 cordate amplexicaul base bracteoles 5-6 x 2-3 mm; the raceme 8-9 cm long, terete, with 4-14 flowers. Flowers light greenish-pink, 7-8 mm long. Pedicel 4-4.5 mm long; the floral bracts small, cordate with amplexicaul base. Sepals 3, subequal, brownish-pink; the dorsal sepal 3.6-4 x 2-3 mm, broader than lateral sepals, cordate, retroflexed; the lateral sepals 5.2 -5.7 x 0.9 - 1.1 mm, spreading, oblong, obtuse, margin recurved. Petals 2, 2.9-3.1 x 0.09-0.1 mm, oblong, obtuse, translucent, whitish-pink, margin recurved. Labellum 2-2.5 x 0.8-1 mm, cordate, slightly deflexed at the middle, hypochile with 4 calli. Column about 3 mm long, winged, 2-lobed. Anther ovate, dorsally dome-shaped, about 0.5 mm long. Pollinia 2, about 0.4 mm long, translucent, orange yellow, clavate-oblong.

Type: INDIA: Sikkim, Bhusuk valley, 10 October 1990. Lucksom (Lucksom 198a Holotype: Gangtok, Forest Department Herb). Isotypes (198b, Gangtok, Forest Department Herb).

Etymology: It is named in memory of my late mother who was a great source of inspiration for the study of this important group of plants.

Flowers and fruits: October - November.

Altitude: 900 m -1200 m.

Ecology: This species grows on the branches of arched shrubs in moist and shady places.

The fresh specimens had light greenish-pink flowers on sub-pendulous peduncle. Leaves coriaceous, or sub-coriaceous, jointed at the pseudobulb or sheath. These characters are of section Coriifoliae Rich. of the genus *Liparis*.

The new species is closely allied to *Liparis*

[1]Accepted October 1991.

[2]DFO M & E (SF/TT), Territorial Circle, Forest Department, Gangtok, Sikkim 737 102.

TABLE 1
DIFFERENCES BETWEEN *Liparis lydiaii* SP. NOV. AND *L. platyrachis*

	L. platyrachis Hook. f.	*L. lydiaii*
Pseudo-bulb	Oblong, compressed, 1.25 cm long.	Ovoid-cylindric, 1-2 cm long, 3.5-6 mm diam.
Leaf	3-5, linear-lanceolate, thickly membranous, 1.5-3 cm long and 0.3-0.5 cm broad.	4, ovato-oblong, thinly membranous with undulating surface, 1-2.7 cm long and 0.4-0.9 cm broad.
Inflorescence	Pendulous, interruptedly winged and with short linear bracteoles.	Sub-pendulous, terete, with 2-3 cordate amplexicaul bracteoles.
Flowers	0.63 cm long and 0.25 cm broad, pale ochraceous yellow.	0.7-0.8 cm long, greenish pink.
Sepals	Dorsal sepal narrower than the lateral sepals, with margin recurved.	Dorsal sepal, cordate, much broader than lateral sepals, margin slightly recurved.
Lip	Quadrate.	Cordate.

platyrachis Hook.f. of the above mentioned section but differs as shown in Table 1.

ACKNOWLEDGEMENTS

I am thankful to Dr. S. Kumar, Botanical Survey of India (Gangtok) for help and for kindly going through the manuscript. Thanks are also due to Dr. N.C. Majumdar, Retd. Scientist-SE, Botanical Survey of India for the Latin translation.

COPIDOGNATHUS KRANTZI, A NEW SPECIES OF HALACARIDAE (ACARI) FROM NICOBAR ISLANDS (INDIAN OCEAN)[1]

TAPAS CHATTERJEE[2]

(With ten text-figures)

Copidognathus krantzi, a new species of Halacaridae, is described here, collected among the phytal sediments of Mus Island (Nicobar islands). Similarity and dissimilarity with related species are discussed.

INTRODUCTION

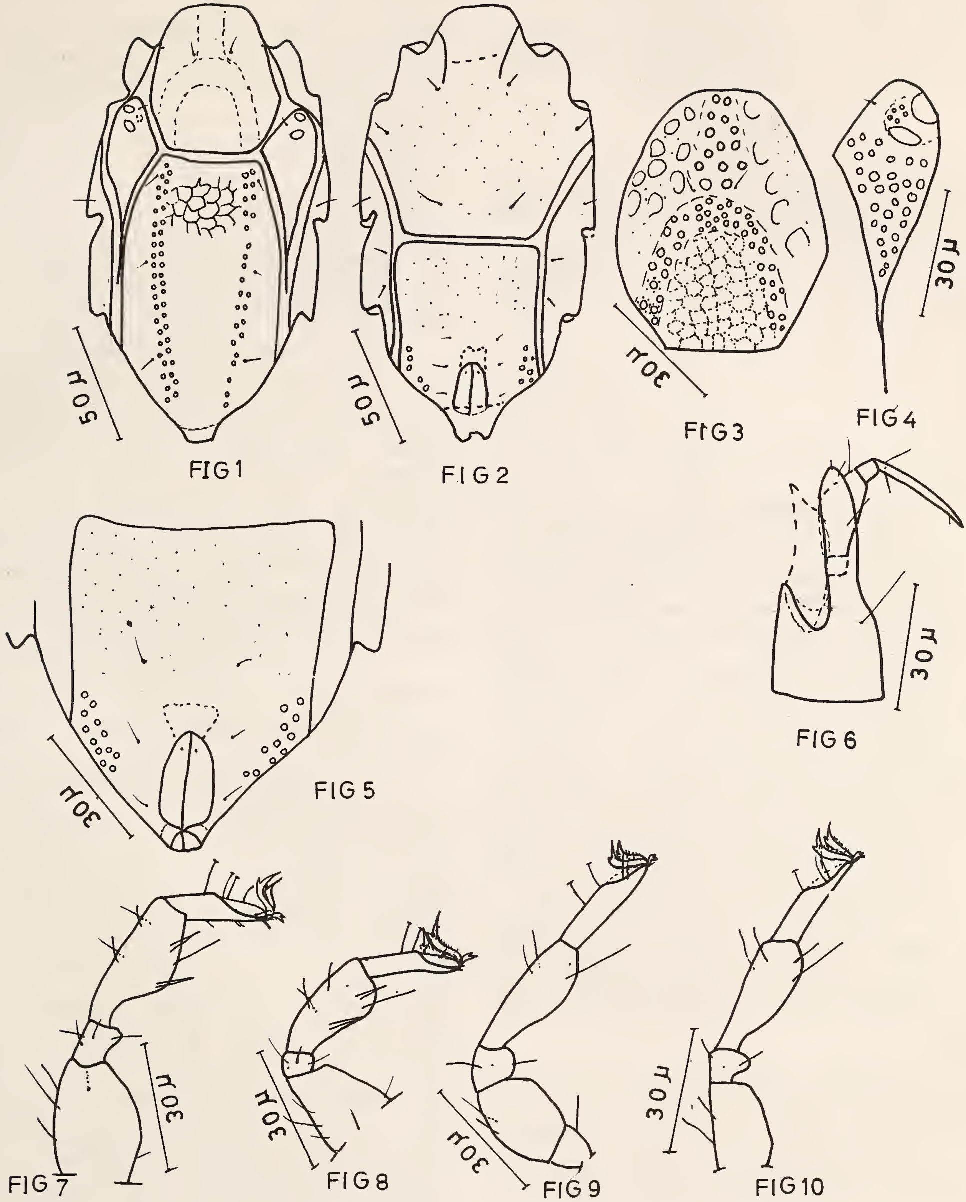
Halacarids are the least known meiofaunal taxa of marine biota in general and particularly so of Indian seas. Halacarids form about 90% of the phytal faunal communities in the upper shore (Bartsch 1988). No meaningful ecological researches can be contemplated without information on taxonomy, zoogeography and biodiversity. Therefore survey of the fauna of halacarids inhabiting the phytal realm was undertaken by the author, resulting in a rich and diverse halacarid collection along the Indian coast. Of these, many turned out to be new species and new records. The present paper describes *Copidognathus krantzi.*

Copidognathus krantzi sp. nov.[3]

Diagnosis: Posterior areolae of antero-dorsal plate inverted-U shaped, ocular plate caudiform posteriorly, postero-dorsal plate with two costae, all ventral plates separate, epimeral process I well developed and coxal in origin, tibiae I and II with 3 ventral setae.

Locality: Three females were collected

[1]Accepted March 1991.
[2]P.G. Dept. of Life Science, Regional College of Education, Bhubaneswar 751007, Orissa.
[3]Named after Prof. G.W. Krantz, a world famous acarologist.



Figs. 1-10. *Copidognathus krantzii* sp. nov.
1. Idiosoma dorsal, female, 2. Idiosoma ventral, female, 3. Magnified view of AD showing areolae, 4. Magnified view of OC showing corneae, areolae and other details, 5. GA of female, 6. Gnathosoma, 7. Telofemur to tarsus of leg I, 8. Telofemur to tarsus of leg II, 9. Telofemur to tarsus of leg III, 10. Telofemur to tarsus of leg IV.

among *Halimeda opuntia* from Mus Island (Nicobar islands).

Type: Holotype in the author's collection in the Department of Life Science, Regional College of Education, Bhubaneswar.

Description

Female: The idiosomal length of females range between 175 μ to 185 μ The various measurements of one of the females are as under:

	Length (μ)	Width (μ)
Idiosoma	183	100
AD	62	51
OC	77	25
PD	104	64
AE	41	55
GA	75	62
GO	24	13
Gnathosoma	56	26

Dorsal plates separate (Fig. 1). Anterodorsal plate (AD) with two areolae, one anterior and one posterior. The anterior areola consists of dark fovea. Posterior areola inverted-U shaped and made up of rosette pores (Fig. 3). Dorsal seta 1 (ds_1) located anterior to the posterior areolae and dorsal seta 2 (ds_2) on the antero-median margin of ocular plate (OC). Two corneae present on OC. The OC caudiform posteriorly (Fig. 4). Postero-dorsal plate (PD) with two costae 2 pores wide. The dorsal setae 3, 4 and 5 (ds_3, ds_4, ds_5) are on the anterior, middle and posterior reaches of PD respectively.

Ventral plates separate (Fig. 2). Anterior epimeral plate (AE) bears 3 pairs of setae and is without any areolae. AE sculptured with fine pores (pycnotic). EpI well developed and coxal in origin.

PE with three ventral and one dorsal seta and a few rosette pores. Three perigenital setae (PGS) present on either side of the GO. The GO with a pair of sclerites and a pair of subgenital setae (SGS) located anteriorly, ovipositor small (Fig. 5).

Rostrum extends upto the base of palpal patella. Palp 4-segmented. Palpal trochanter (P_1) and patella (P_3) without any seta. Palpal femur (P_2) with one dorsal seta. Palpal tibiotarsus (P_4) with three basal setae and one distal eupathidia. A pair of proto-, deuto-, trito-, and basirostral setae are present on Gnathosoma (Fig. 6). Tectum short and dorsally sculptured with fovea.

Chaetotaxy of legs I-IV is as follows:

Trochanter	1-1-1-0
Basifemur	2-2-2-2
Telofemur	5-5-2-2
Patella	4-4-3-3
Tibia	7-7-5-5

Chaetotaxy of tarsi is discussed in the text.

Telofemorae III and IV devoid of ventral setae.

Tibiae I and II with 3 ventral setae and 4 dorsal setae (Figs. 7, 8). Tarsus I with 3 ventral setae (one basal and two distal filiform setae), 3 dorsal long setae, one solinidion, one profamulus and four PGS (two doublets eupathidia) (Fig. 7). Tarsus II bears 3 dorsal long setae, one solinidion, and two PAS (two singlet eupathidia) (Fig. 8). Tarsi III and IV with 4:3 dorsal setae (Figs. 9, 10). PAS of tarsi III and IV are not discernible.

Male, larva and nymph: Not found in the samples collected.

Distribution: Bay of Bengal (eastern Indian Ocean).

The species can be assigned to the key group 5200 of Newell (1984) as it possesses EpI coxal in origin, ds_2 on OC, ds_3 on PD, single pair of basirostral seta, telofemorae III and IV devoid of ventral setae, parallel striae on the cuticular membrane between AD and PD. Further, certain characters like the body size, long and posteriorly caudiform OC, well developed EpI coxal in origin and telofemora III and IV lacking ventral seta relate the species also with *Copidognathus oculatus* group (Bartsch 1977). The present species is demarcated from the members of the key group 5200 and *C. oculatus* group in having an inverted-U shaped posterior areola and a foveatus anteriar areola.

C. ypsilophorus Newell, 1984 belonging to 5200 possessing an inverted Y shaped areola, resembles the present species but differs in having the areola commencing away from the

posterior margin of AD, costae 5-7 rosette pores wide in the middle, and 2-3 pore wide paracostae. *C. propinqus* Newell, 1951 and *C. orientalis* Newell, 1951 resemble the present species in the shape of the posterior areolae. However, the caudiform nature of OC, ds_2 on OC, and small size of the present species separate it from the two species.

C. krantzi sp. nov. resembles *Arhodeoporus thyreoporus* Andre, 1959 also in the shape of areolae of AD, presence of two costae on PD, and caudiform OC. But in *C. krantzi*, the ventral plates are separate and tibiae I and II bear three ventral setae while in *A. thyreoporus* the ventral plates are fused and tibiae I and II have four ventral setae.

ACKNOWLEDGEMENTS

Thanks are due to Dr. A.L.N. Sarma, I/c Zoology Division, Regional College of Education, Bhubaneswar for guidance, to Dr. Ilse Bartsch, Biologische Anstalt Helgoland, Hamburg (FRG) for her ready help in providing the necessary literature.

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REVIEWS

FLORA OF THE INDIAN DESERT. Second edition, by M.M. Bhandari. pp. viii + 435 (24 x 18 cm), with 36 illustrations and 114 coloured photographs. Jodhpur, 1990. MPS repros. Price: Rs. 600, $ 60 or £ 40.

This is the second edition of the flora first published in 1978, written by an emeritus professor of Botany of the University of Jodhpur. The first edition proved so popular that it was quickly exhausted, requiring this second revised and enlarged edition. This work gives a complete account of the flora of the Indian desert, comprising information on 619 species of vascular plants belonging to 315 genera and 78 families covered in 443 pages, as compared to the roughly 120 page FLORA OF INDIAN DESERT by Blatter and Hallberg in the BNHS *Journal,* published between 1918 and 1921. The flora is a living story of 40 years of exhaustive experience and reflects the accomplishments of a lifetime well spent. The author's understanding of the plants of the Indian desert is second to none, as it stands today.

In this work, the author has incorporated three new species and three new infraspecific taxa described by him during the period of this work. Besides the new descriptions he has proposed about a dozen new names of earlier known plants, as per the International Code of Botanical Nomenclature, after the careful study of these plants. All these contributions will remain immortal additions to Indian botany.

In the preface to the book, the author has recorded his awareness about the printing errors in this volume and referred to the errata and corringenda in the appendix. However, the copy received for this review is devoid of any such appendix. I am sorry to say that there are a large number of typographical errors in the text. Very often these errors are in publication dates which are very dangerous in taxonomical works, where priority of publication is the issue under contention. I am listing below some of the omissions and errors.

1. *Dentella repens* (L.) Forst & Forst (see p. 168). Actual number of plate in the citation of the figure is missing.

2. *Acanthospermum hispidum* DC. (p. 171). In the reference to Santapau, volume and page number are wrong. The year of publication is missing.

3. *Portulaca oleracea* L. (p. 49). Under this taxon there are two descriptions (one complete and the other incomplete) and three sets of local names and exsiccata. The incomplete description and the exsiccata followed by it perhaps belongs to *Portulaca quadrifolia* L., while the second set of exsiccata belongs to *P. tuberosa* Roxb.

4. *Abutilon fruticosum* Guill. & Perry var. *fruticosum* (p. 56). Exsiccata, distribution and other data under this taxon are missing.

5. *Abutilon indicum* ssp. *quinense* (Schum.) Borss. (p. 57). The portion of distribution of this species is missing.

6. *Sphaeranthus senegalensis* DC. (p. 189). Citation of *S. indicus* Hk.f. in FBI (non Linn., 1753) is confused due to a typographical error.

7. *Convolvulus auricomis* var. *volubilis* (p. 218-9). Here the author's name A. Rich. should go in parenthesis, followed by the name of the proposer of the combination, e.g. Bhandari. Similar example should follow in next variety (var. *ferguinosus*) also.

8. *Salvia santolinifolia* Boiss. (p. 284). Description of this species is completely missing.

9. *Sueda fruticosa* (L.) Forsk. (p. 298). Citation of J.D. Hooker's reference in FBI is a mixture of two references (Hk. f. in FBI and Cooke in FPB)

10. *Enicostemma axillare* (Lamk.) Raynal (pp. 205-6). A Note under this species advocates adoption of *E. hyssopifolia* (Willd.) Verdoon as a correct name of the species, which was accepted in the first volume of the flora. In this revised edition a new name has been adopted but the note regarding earlier illegitimate synonym still appears in the text.

11. *Asparagus racemosus* Willd. (p. 317). Citation of this species from Cook's flora is erroneous, because Cooke actually mentions var. *javanica* of Baker on p. 270 (not p. 269).

The following few names may require some explanation and precise citations of correct references:

1. In the note under *Wrightia tinctoria* R. Br. (p. 195), it is mentioned that Woodson (1930) equates *W. tinctoria* R. Br. with *Apocynum vincaefolium* Burm. f. However, the author has not given this reference either in the citation or in the bibliography. The same applies to Merril's opinion about *A. vincaefolium* Burm. f.

2. *Adhatoda* Mill. (p. 262). Genus *Adhatoda* Nees ex Wall. is conserved (1832) against *Adhatoda*

TABLE 1

RECENT NOMENCLATURE CHANGES, WHICH MAY REQUIRE TO BE ADOPTED FOR SOME SPECIES

Name adopted here	Name proposed as correct by other authors (not recorded in the synonymy)
1. *Commicarpus verticillatus* auct. = *Boerhavia verticillatus* sensu Hook. f. in FBI	*C. helenae* (Schult.) Meikle (see Notes Roy. Bot. Gard. Edinb. 36: 246, 1978).
2. *Urginia indica* (Roxb.) Kunth. (p. 318)	*Drimia indica* (Roxb.) Jessop. (see J. South Afr. Bot. 43: 265, 1977).
3. *Amischophacellus axillaris* (L.) Rao & Kamathy (p. 319)	*Tonningia axillaris* (L.) Kuntze (see Bennet, Name Changes 567, 1987).
4. *Fimbristylis quinquelocularis* (Vahl) Kunth. (p. 340)	*F. miliacea* (L.) Vahl. (see Blake in JAA 35 : 216, 1954)
5. *F. spathacea* Roth (p. 340)	*F. cymosa* R. Br. (see Kern, in Fl. Males. 7(3): 557, 1794).
6. *Solena heterophylla* Lour. (p. 158)	*S. amplexicaulis* (Lamk.) Gandhi (see Fl. Hassan Dist.)
7. *Adina cordifolia* Willd. ex Roxb. (p. 167)	*Haldinia cordifolia* (Willd. ex Roxb.) Ridsdale (see Blumea 24: 361, 1978).
8. *Glossocardia setosa* Blatt. & Hallberg (p. 178-9)	*G. bosvallia* (L.f.) DC. (see Rao *et al.* Fl. Ind. Enum. Asteraceae 41, 1988).
9. *Lactuca runcinata* DC. (p. 181)	*Launea intybacea* (Jacq.) Beauv. (see Kew Bull. 18: 472, 1966).
10. *Atylosia scarabaoides* (L.) Benth. (p. 101)	*Cajanus scarabaoides* (L.) Thuars (see Van der Meusen, Agricultural Univ. Wageningen paper 85-4: 183, 1985.
11. *Launea procumbens* (Roxb.) Ramaya & Rajgopal (p. 182).	*L. obtusa* (DC.) Almeida (Fl. Savantwadi 231, 1990).
12. *Merremia emarginata* (Burm.f.) Hall. f. (p. 234)	*M. gangetica* (L.) Cufo. (see Bull. Jard. Bot. Brux. Suppl. 31: 743, 1961).
13. *Solanum surattense* Burm. f.	*Solanum virginianum* L. (see Kew Bull. 41: 434, 1986).
14. *Hygrophila auriculata* (Schum.) Haine (p. 270).	*H. schulli* (Buch.-Ham.) Almeida & Almeida (see JBNHS suppl. 83: 1986).
15. *Paspalum distichum* sensu Hk.f. in FBI	*P. vaginatum* Sw. (see also Bennet 414, 1987).
16. *Hibiscus punctatus* Dalz.	*H. amblyocarpus* Hochst. (see BOBSI 12: 174, 1972).
17. *Malva parviflora* auct. (non-Linn.); Master in FBI	*M. chinensis* Mill. (Bennet, 359, 1987).
18. *Oxalis latifolia* auct. non. H.B.K. (p. 87)	*O. dehradunensis* Raizada
19. *Grewia abutifolia* sensu Masters in FBI (non Vent. ex Juss., 1804).	*G. aspera* Roxb. (see JBNHS 34 (4): 888, 1931).

Mill. (1754). Therefore, the citation of Miller's name as the author of this genus is incorrect. However, it can be shown with Miller's name in square brackets followed by Nees ex Wall. *Adhatoda* [Mill.] Nees ex Wall. (Pl. As. Rar. 3: 102, 1832).

A. zeylanica Medic. (1790), however, is a validly published name under this genus under special provision of Article 62-2 of ICBN. Otherwise names published under genera that are not validly accepted are considered nomina nuda and rejected under the rules of the code.

2. *Abutilon bidentatum* Hochst A. Rich. (p. 56). I believe this name is based on *Sida bidentata* Hochst. Therefore the correct name should go as *A. bidentatum* (Hochst.) A.-Rich. The basionym *Sida bidentata* Hochst. also should be cited in the

synonymy.

3. *Amaranthus graecizans* L. ssp. *thellungianus* (Nevski) Gusev. (p. 291). *A. polygonoides* sensu Roxb. is published before the same name used by Townsend. Therefore the citation of Roxburgh should precede Townsend.

4. *Alternanthera pungens* Kunth. (p. 290). *Achyranthes repens* L. (1753) is cited in the synonymy of this species. Why the specific epithet *repens* not available for this species is not clear from the nomenclature.

5. *Boerhavia diffusa* Linn. (p. 285). Among the various specific epihets used for this taxon by Linnaeus it appears that *B. repens* L. was first accepted by J.D. Hooker in FBI at species level, merging others as varieties. Therefore *B. repens* L. should be the correct name for this taxon.

6. *Abutilon pannosum* (Forst.f.) Schlecht (p. 58). Schlecht's (1951) name appears to be a later homonym of Webb's (1835) name which is based on an entirely different taxon *Sida pannosa* R. Br. (1818) (non Forsk. f., 1787).

7. *Solanum indicum* L. (p. 245). This name is considered by recent authors as nomen confusum and rejected. The plant from the Indian desert is not a Linnean species and this name is not applicable here. Plant intended here may be *S. violaceum* Ortega.

8. *Sida alba* L. (p. 66). The earlier valid name for this species appears to be *S. spinosa* L. If this name is applied partly to this taxon (pro parte ? excl. type?) is not clear from citations. If, however, that is the case, then the other correct name for this taxon available is *S. alnifolia* L. (1753), which is mentioned by Masters in FBI.

9. *Stellaria media* (p. 47). This combination appears to have been made by Cyrill in 1784 (see *JBNHS 24 (2):* 304, 1930.).

10. *Aerua persica* (Burm.f.) Merrill (p. 288). J.D. Hooker, in his Flora of British India, is the first author to unite *Irsine persica* and *I. javanica* of Burman under *Aerua javanica* Juss. Therefore the first reduction of *I. javanica* Burm. f. in synonymy of *A. persica* (Burm.f.) Juss. ex Schult. reduces the status of the epithet *javanica* as a synonym of *A. persica.*

11. *Moringa oleifera* Lamk. (p. 95). This name is nom. illegit. according to ICBN rules because the original description of this taxon incorporates the names of other validly published species.

12. *Indigofera argentea* L. (p. 101) has priority over the accepted name *I. caerulea* Roxb. However, *I. argentea* L. is nomen illegit. being the later homonym of Burman's name (1768). Therefore (non Burm. f., 1768) should be cited after reference of Linnean name to make the nomenclature clearly understandable.

13. *Vigna trilobata* (L.) Verdcourt (p. 126). Synonym under this taxon is confused.

14. *Lindernia muraria* (Roxb. ex D. Don) P. Bruel (p. 252). *L. indica* (L.) Vatke cited in the synonymy of this taxon has priority over the accepted name.

15. *Veronica anagallis-aquatica* L. (p. 258). Under this name citation shows that this name has been accepted by J.D. Hooker in FBI and T. Cooke in FPB. However both these authors have adopted the name *Veronica anagallis* L. for this taxon.

A number of nomenclatural changes have appeared in the recent literature, which may require adoption for some of the species mentioned in this book. Some of the name changes are listed in Table 1.

M.R. ALMEIDA

A REVISED HANDBOOK TO THE FLORA OF CEYLON Vol. 6. Edited by M.D. Dasanayake and F.R. Fosberg. pp. ix + 424 (24.5 x 16 cm). New Delhi, 1987. Amerind Publishing Co. Pvt. Ltd. Price not mentioned.

This volumes, the sixth of the series, consists of taxonomic accounts of 22 families and three genera of one additional family distributed in Ceylon (Sri Lanka). The families have been arranged in alphabetical order. As in previous volumes of the series, families have been handled by different authors, each with expertise in the taxonomy of the respective families. However, this leads to an overall inconsistency of style, since the presentation by different authors is different. As each writer concentrates on revisions of his/her specialities on the wider range of areas, minute details which may not be relevant in this type of regional flora have been lumped together, resulting in disproportionate size of treatment in some cases.

While reading this volume some of the things which I have not followed or which seem to be contrary to the presentation in this volume are given below:

1. (p. 316) – *Solomonia ciliata* (L.) DC., Prodr. 334, 1824: This name in the form of a new combination based on *Polygala ciliata* Linn. as a basionym is given as a correct name for the species. However the same name, originated from very same publication, is given in the synonymy with the citation as nomen illegitimatum. If, in fact, De Candolle has not based his name on the Linnean *basionym* then it should be treated as a new name originating from 1824. If it is based on the basionym *Polygala ciliata* Linn. then the combination is the correct name and repeated citation of the same followed by remarks nom. illegit, should be eliminated. Secondly, if *Salomonia ciliata* DC. is considered as a new name from 1824, it will compete with *S. oblongifolia* DC. Since both names appear in the same publication, the choice of the correct name will fall on whoever has chosen to unite these two species.

2. (p. 339) – *Psychotria forsbergii* Sohmer (1977) seems to have priority over the accepted name *Psychotria sohmeri* Kien. (1986). Why the earlier name cannot be accepted is not clear from the nomenclature cited.

3. In this volume various authors have cited figures and illustrations of various species, particularly if they are cited in original protologue, as the lectotypes of species. In my opinion it is an unfair practice. In Article 9 of the ICBN there are two sub-clauses which should enlighten us on this matter. Clause 9.1 states that "the type (Holotype, Lectotype or Neotype) of a name of the species or an infraspecific taxon is a single specimen or other element." (In this context a figure or drawing which is produced in a number of copies cannot be taken as the type, mentioned in one of the three categories given above). Sub-clause 9.3 states, "If it is impossible to preserve a specimen as the type of the name of the species or the intraspecific taxon then the type may be a description or a figure." It is clearly understood here that the description or the figure can be used as the substitute for the clearly defined types when no specimen of the species is available for the designation of the type. In this regard ICBN specifically insists on the sequence of Holotype, followed by Lectotype, followed by Neotype and as a last resort, when none of the specimens is available, allows the use of figures and descriptions for the purpose of types as comparative material. No specific terminology for typification based on figures and description is suggested in the code.

In other words, it is understood that figures and descriptions are to be used as types only in cases where the species are considered extinct and no more available for preservation. Therefore, when there are a number of specimens available from old as well as fresh material for designating the types it is not only wrong practice, to designate figures as types, but also a gross contravention of the spirit of the rules of typification.

Under *Rhapidophora decursiva* (Roxb.) Schott and *R. pertusa* (Roxb.) Schott, Dr. Nicolson has cited a number of specimens from Ceylon and I am sure there are some more at Central National Herbarium, Calcutta (CAL). However, he accepts Sealy's selection of Roxburgh's drawing at Kew as type for *R. decursiva* (Roxb.) Schott and cites Rheede's plate of 'Elattadi Marawara' for *R. pertusa* (Roxb.) Schott.

In accordance with the rules, lectotype should be designated from the specimens associated with the original protologue of these species and if none of the original material is available, neotype can be chosen.

I am unable to understand the choice of Wight's figure (Icon. pl. Or. 3: t. 802, 1844) as the type of *Amorphophallus sylvatica* (Roxb.) Kunth.

The implications of accepting figures as types with reference to some work presented in this volume will be published in this journal separately, for the sake of brevity of this review.

One more aspect of this volume and others in the series, is that in spite of so much taxonomic work in India, references to taxonomic works in India are very meagre.

I must appreciate here that the quality of printing and production of this series is far superior to some of our Indian regional floras, which are not only costly but are full of typographical errors and nomenclatural mistakes.

Not only this volume but the entire series is worth its cost for research and educational institutions and even for individuals.

M.R. ALMEIDA

MISCELLANEOUS NOTES

1. INTERSPECIFIC PLAY BEHAVIOUR BETWEEN HANUMAN LANGUR *PRESBYTIS ENTELLUS* AND RHESUS MACAQUE *MACACA MULATTA*

Polyspecific associations in non-human primates have been reported from a number of study sites (Bernstein 1967, Freeland 1977, Rudran 1978, Das and Sharma, 1980). Association of macaques *Macaca mulatta* with langurs *Presbytis entellus* has also been noted in different places (Parthasarathy 1972, Roonwal and Mohnot 1977, Pirta 1984). In Jaipur *Presbytis entellus* and *Macaca mulatta* coexist at Ambagarh Reserve Forest 9 km north-east of Jaipur city, where five groups of rhesus monkeys and one group of langurs live. The home ranges of the two species overlap and both species mix during provisioning of food by pilgrims. Data on interactions between these two species were collected systematically early morning and evening during 1986-1987 for 350 hours. "Sampling all occurrences of some behaviour" was the method (Altmann 1974) for recording interactions. Most of the time (65.7%) the individuals of the two species were not in association (distance between the species more than 10 m). They mixed with one another only 34.3% of the time.

Play behaviour between juveniles and infants of both species was significant. This kind of affinitive behaviour was observed mostly during evening hours. Out of total 456 episodes (all kinds of interactions) 140 play interactions took place between rhesus juveniles and langur juveniles. On 22 occasions play was between rhesus juveniles and langur infants (Table 1). But langur infants played with rhesus juveniles only in the vicinity of their mothers. Interactions between infants of the two species were mostly play. Langur juveniles played a great deal with rhesus juveniles (81.7%), and somewhat less with rhesus infants (69.3%). Langur infants initiated play only with rhesus juveniles and infants (Table 2).

The play behaviour observed during the study was varied, such as play initiation, somersaulting, chase, touch and non-contact (Dolhinow 1972). Infants raised in polyspecific groups like this could be expected to develop social bonds with other species.

B. RAM MANOHAR
REENA MATHUR

December 3, 1990

TABLE 1

RHESUS JUVENILE AND INFANT INTERACTION —PLAY BEHAVIOUR TOWARDS LANGUR YOUNG

Transmitter	Receiver	Chase	%	Supplant	%	Threat	%	Attack	%	Play	%	Misc.	%	Total
RJ	LJ	51	16	57	17.9	46	14.5	19	5.9	140	44.1	4	2.2	317
RJ	LI	0	0	0	0	0	0	0	0	22	100.0	0	0	22
RI	LJ	10	18.8	1	1.8	5	9.4	3	5.6	27	50.9	7	13.2	53
RI	LI	13	11.1	4	3.4	13	11.1	6	5.1	79	67.5	2	1.7	117
		74		62		64		28		268		13		509

RJ = Rhesus juvenile, RI = Rhesus infant, LJ = Langur juvenile, LI = Langur infant.

TABLE 2

LANGUR JUVENILE AND INFANT INTERACTION — PLAY BEHAVIOUR TOWARDS RHESUS MACAQUE YOUNG

Transmitter	Receiver	Chase	%	Supplant	%	Threat	%	Attack	%	Play	%	Misc.	%	Total
LJ	RJ	12	7	6	3.5	12	7	1	0.5	139	81.7	1	0.5	171
LJ	RI	1	2	5	10.2	5	10.2	4	8.1	34	69.3	—	—	49
LI	RI	—	—	—	—	—	—	—	—	28	100.0	—	—	28
LI	RI	2	2.8	1	1.4	4	5.7	2	2.8	58	84	2	2.8	69
		15		12		21		7		259		3		317

RJ = Rhesus juvenile, RI = Rhesus infant, LJ = Langur juvenile, LI = Langur infant.

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2. NOTES ON THE FOOD HABITS OF NILGAI *BOSELAPHUS TRAGOCAMELUS*

In the course of a study on the status and distribution of mammals in Keoladeo National Park, Bharatpur, casual observations were made on the food habits of the nilgai *Boselaphus tragocamelus* from September 1984 to September 1985. Records were also made on the food plants of a tame free ranging nilgai.

In total 48 plant species were observed to be eaten. Of these 13 were tree species, five creepers /stragglers, 16 herbs and nine grasses (Table 1).

In areas where grass was burnt nilgai fed on sprouting shoots of grasses such as *Scirpus tuberosus, Vetiveria zizanoides, Desmostachya bipinnata* and *Cynodon dactylon.* In burnt areas it also fed on fallen *Zizyphus jujuba* fruits and sprouting leaves of *Acacia nilotica, Prosopis spicigera* and *Salvadora persica.*

During leaf shedding season (February and March) the nilgai fed on fallen leaves of *Mitragyna parvifolia.* Similarly, fallen leaves and fruits of *Zizyphus jujuba* were eaten by them from December to February. During monsoon and post monsoon they fed mainly on herbs and grasses. Dry pods of *Prosopis chilensis* and *Acacia nilotica* were also taken during summer.

Studies on food habits of nilgai in Asia show that they are browsers (e.g., Mirza and Khan 1975), while in southern Texas they are grazers (Sheffield *et al.* 1983). However, quantitative studies are required under Indian field conditions to know more about their food habits.

K. SANKAR

March 5, 1991 V.S. VIJAYAN

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TABLE 1
SOME IMPORTANT FOOD PLANTS OF NILGAI IN KEOLADEO NATIONAL PARK, SEPTEMBER 1984 TO SEPTEMBER 1985

Plant species	Monsoon July – Oct.	Winter Nov. – Feb.	Summer March – June
Trees			
Acacia nilotica	L	L	L, Fr
Ficus religiosa		L	
Mitragyna parvifolia	L	L	L
Phoenix sylvestris	L	L	Fr
Prosopis chilensis		L	Fr
P. spicigera		L	L
Salvadora persica		L	L
Zizyphus jujuba	L	L, Fr	L
Shrubs			
Capparis sepiaria	L	L	L
Kirganelia reticulata		*L*	
Zizyphus nummularia	L	L	L
Climbers			
Cocculus hirsutus	L	L	
Dreggea volubilis	L	L	
Herbs			
Achyranthes aspera	L	L	
Ageratum conyzoides	L	L	
Corchorus aestuans	L	L	
C. capsularis	L	L	
C. olitorius	L	L	
Euphorbia hirta	L	L	
Peristophe bicalyculata	*L*	*L*	
Phyllanthus niruri	L	L	
Physalis minima	L	L	
Sida rhombifolia	*L*	*L*	*L*
Vernonia cinerea	L	L	
Grasses			
Cynodon dactylon	L	L	L
Desmostachya bipinnate	L	L	L
Paspalum distichum	L	L	L
Scirpus sp.	L		L
S. tuberosus	L	L	L
Saccharum sp.	L	L	L
Setaria verticillata	L	L	L
Vetiveria zizanioides	L	L	L

L – Leaves, Fr – Fruits.

3. MARBLED TEAL *MARMARONETTA ANGUSTIROSTRIS* (MENETRIES) IN WESTERN INDIA

While two of the authors (SAA, JKT) were trapping and ringing waders at the *dhandh* of Chhari (Kutch), Gujarat, the site was visited by NNB on February 11, 1990. He pointed out a group of marbled teal *Marmaronetta angustirostris* at some distance in the lagoon. On properly observing the

birds through a telescope we took a count; and by our estimate there were about 200 of this rare teal present. As far as we are aware, this is the largest collection of *M. angustirostris* recorded within our limits. The sky was overcast with intermittent sunshine, but the visibility was good. We wonder whether our sighting was an indication of the successful reintroduction of this species, e.g. at Lal Suhanra Reserve (Pakistan). So far it has been recorded in this part of the country as a rare straggler, including one bird obtained in Kutch in 1940 (BIRDS OF KUTCH, Ali, S. 1945, p. 169).

S.A. AKHTAR
J.K. TIWARI
April 4, 1990 N.N. BAPAT

4. BALLOONS AS A DEVICE FOR SCARING BIRDS

I closely observed the roosting of a flock of 32 pariah kites *Milvus migrans govinda* from 1987 to 1989. The birds used to occupy high branches of *Eucalyptus* trees just in front of my (Aligarh) residence. They were regular in their roosting hours and slept undisturbed except on windy and rainy days.

One evening, when my daughter was playing with an gas filled balloon of dark grey colour, the balloon flew up and got entangled in the central branch of a tree in the *Eucalyptus* grove where the kites used to roost. It was becoming dark and kites started arriving within 10 minutes. As soon as some of them saw the hanging balloon they became alarmed and left the roosting branches and circled the tree with typical calls. At times even they mobbed the balloon but when nothing happened, after 15 minutes all the kites moved away and did not roost there for the night. The balloon remained hanging for three days and some birds did return on the second day, but after seeing the balloon still hanging, moved away. The kites then deserted the site finally and did not return for the next three months, when the *Eucalyptus* trees were cut down.

It appears that at times balloons could be effectively used to scare away birds .

May 31, 1990 H.S.A. YAHYA

5. UNUSUAL NESTING SITE OF BRAHMINY KITE *HALIASTUR INDUS*

The brahminy kite *Haliastur indus* is the most common raptor in the coastal fishing village of Kodikkarai at Point Calimere, Tamil Nadu. Large numbers congregate here during the fishing season and along with gulls they are the major scavengers. Several of these birds stay back even after the fishing season gets over in March and their nesting activity starts around mid-January. Usually they nest about 6–15 m up in large banyan, peepul, tamarind, neem, casuarina or other trees (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983). At Point Calimere, palmyra *Borassus flabellifer*, coconut *Cocos nucifera* and bhendi *Thespesia populnea* are the more common nesting trees.

On 14 February 1990 a brahminy kite was flushed beside a low earth bund passing through the mudflats of the Great Vedaranyam Swamp. A complete nest with two eggs was seen at that spot under a two metre tall *Prosopis chilensis* bush growing on the slope of the bund. The nest was constructed the usual way but it was right on the ground, about 12 m away from the water's edge. Twigs of *Prosopis chilensis, Arthrocnemum indicum, Suaeda* sp., mud and cowdung were used to line the nest. The bund passes between the natural mudflats and the reservoir used for storing sea water for salt extraction. One of the birds was again seen incubating the eggs the next day, while another sat a little away on the mudflat. Unfortunately the nest was preyed upon after a couple of days, probably by a mongoose or a jackal, and the kites abandoned the site.

This is the first time a brahminy kite nest has been located on the ground. Menon (1989, unpubl. report submitted to BNHS) located 48 nests during his brief study at Point Calimere and all were on trees. It is interesting to note that the pair chose to nest on the ground although there are plenty of regular nesting trees around the area (though not in the immediate vicinity of the site), and there seems to be hardly any competition for nest sites among the kites.

WILLIAM MORRISON
LIMA ROSALIND
S. BALACHANDRAN

March 29, 1990

6. GREAT STONE PLOVER *ESACUS MAGNIROSTRIS* (VIEILLOT) IN KERALA

On 14 January 1990 at 1030 hrs while doing the mid winter waterfowl count at Puduvyppu Mangrove Forest, Kerala, a great stone plover *Esacus magnirostris* (Vieillot) was sighted. The Puduvyppu Mangrove Forest comes under Elangapuzha panchayat of Cochin taluk in Ernakulam district. The altitude of the area is 1.7 m above mean sea level. This forest is located approximately 6 km from Ernakulam city and it covers an area of about 100 ha.

The bird was feeding in the tidal mudflats, along with other waders like sandpipers, sand plovers, Kentish plovers, roof herons and egrets. Thousands of gulls and terns were also present.

November 26, 1990

P.O. NAMEER

7. POSSIBLE OCCURRENCE OF FOUR SUBSPECIES OF LESSER SAND PLOVER *CHARADRIUS MONGOLUS* AT PT. CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

Cramp and Simmons (1983) recognised five subspecies of lesser sand plover *Charadrius mongolus* under two groups. The *mongolus* group comprising *Charadrius mongolus mongolus* and *C.m. stegmanni*, and the *atrifrons* group containing *pamirensis, C.m. atrifrons* and *C.m. schaeferi*. The two groups are separated on measurements and the extent and spread of black on the head in their breeding plumage. The lesser sand plover wintering in western India is mostly *atrifrons* group, *pamirensis* wintering in western India and *atrifrons* wintering in the Bay of Bengal area and Indian subcontinent west to Pakistan (Cramp and Simmons 1983). While handling lesser sand plover for ringing at Point Calimere Sanctuary, Thanjavur district, Tamil Nadu, three individuals which varied in measurements and plumage were noticed. They were carefully examined and the measurements analysed to determine their race. It was apparent that the three individuals belonged to races different from the subspecies *atrifrons* (Himalayan race) commonly wintering in India. One (Specimen no. 1) had very short tarsus (27.5 mm), another (no. 2) had a longer bill (21 mm) and the third (no. 3) differed in the absence of black on the forehead in its breeding plumage. These three birds, on the basis of analysis of key characters were identified as *Charadrius mongolus stegmanni, C.m. schaeferi and C.m. pamirensis* respectively (Table 1).

Charadrius mongolus stegmanni: This race is of east Siberian origin and winters mainly along the Chinese seaboard, Philippines, Eastern Indonesia, Melanesian islands and Australia. The tarsus measurement (27.5 mm) does not fall within the range of the five races given by Cramp and Simmons (1983). However, it falls within the range of the tarsus measurements (27–34 mm) of the *mongolus* group given by Prater *et al.* (1977). Moreover the bill length/bill depth ratio and wing/tarsus ratio tallies with *stegmanni*. So far it was assumed that only the *atrifrons* group winters in India. This record of *stegmanni* from Point Calimere indicates that stray individuals of the *mongolus* group also visit India along with members of the *atrifrons* group.

Charadrius mongolus schaeferi: The west Chinese race *schaeferi* winters along the gulf of Siam, Malaysia and Western Indonesia (Greater Sundas). The race has also been recorded from western Australia (Lane 1986). The maximum range of the bill length (21 mm) is noted only in *schaeferi* by Cramp and Simmons (Table 1). The wing/tarsus

TABLE 1
MORPHOMETRIC DATA FOR THE THREE RACES OF LESSER SAND PLOVER CAUGHT AT PT. CALIMERE

Specimen no., species, sex	Wing	Bill	Tarsus	Tail	Wt. (g)	Wing/ Bill ratio	Wing/ Tarsus ratio	Bill length/ Bill depth ratio	Date of capture
1. *Charadrius mongolus stegmanni*, F	125	17.7	27.5	49.5	47	7.1	4.5 *(4.20-4.78)	3.76 *(< 3.00 *mongolus* group)	15.3.90
2. *Charadrius mongolus schaeferi*, M*	130 (127-134)	21 (17-21)	34 (33-36)	51	53	6.19	3.82 *(3.50-4.06)	4.4 *(> 3.80 *atrifrons* group)	12.4.90
3. *Charadrius mongolus pamirensis*, F*	128 (128-134)	17.2 (16-18)	33 (32-34)	49	57	7.4	3.9	3.6 *(3.57-4.07) (From Ladakh and Kashmir)	28.4.90

* Measurement ranges given by Cramp and Simmons (1983). M = Male, F = Female.

ratio also tallies with *schaeferi*. Though *schaeferi* comes under the *atrifrons* group its occurrence in India has not been definitely stated by Ali and Ripley (1983) as it is mentioned as *atrifrons*. It is not clear whether they meant the *atrifrons* group or the race.

Charadrius mongolus pamirensis: The western race winters in western India, Pakistan, the Arabian Sea, Persian Gulf, Seychelles and East Africa, south to Cape Province and Namibia (Cramp and Simmons 1983). The female specimen collected in breeding plumage had mottled white patches on sides of forehead, and dark brown tinge on ear coverts, which tallies with the colour pattern of *pamirensis*. As this race has been known so far to winter only in western India, its occurrence in south-east India is noteworthy.

It is possible that all four subspecies of both groups winter in India as in Australia, where the three subspecies of both groups of lesser sand plover have been reported by Lane (1986). More data are being analysed to determine the races of lesser sand plover wintering in south India.

S. BALACHANDRAN
V. NATARAJAN

July 16, 1990

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8. OCCURRENCE OF *LARUS MINUTUS* PALLAS IN KUTCH

NNB saw what he thought was a little gull *Larus minutus* at Rudramata dam on 27 November 1987. On a subsequent visit to the dam by H, Shantilal Varu and others, the bird was not found to be present there. It appears that Dr. Salim Ali came across a number of these gulls in the Rann of Kutch which he watched from a distance (*JBNHS 71:* 3), but withheld definite indentification of them.

NNB along with the other members of the Pelican Nature Club of Kutch saw three *L. minutus*

on 19 December 1989 at Shinay dam (Anjar environs). On 21 December H accompanied NNB and the others on a visit to the dam again, when only one bird was present there. The gull was in juvenile or immature plumage; its size, tern-like habit of picking up food from the surface of the water, its colouration, including the zigzag pattern on the wings, dark patch on the crown, no black feathers on the underside of the wings, a black band at the end of the tail and dull red legs and feet, all pointed to its being the little gull. The only feature we must take note of was the colour of the bill, which was dull red with a dark tip, not mentioned in any of the references we have at hand except BIRDS OF COAST AND SEA (Bruce Campbell 1977) wherein it is stated: "…..and the bill turns from red to blackish", describing the winter plumage. The gull seen by us repeatedly came to settle for a while on a slab of stone less than 100 m from where we were standing.

N.N. BAPAT
August 16, 1990 M.K. HIMMATSINHJI

9. ON THE BLACK TERN *CHLIDONIAS NIGER NIGER* (LINN.)

On 25 May 1989 at about 1800 hrs, a single specimen of the black tern *Chlidonias niger niger* (Linn.) was obtained by me from a fisherman on the beach at Point Calimere Sanctuary, Tamil Nadu. The tern was apparently cast ashore by high wind and gales that had been blowing for the previous two days. The following observations were taken during the six day period that the bird remained with me due to its inability to fly.

The measurements are as follows: bill from feathers : 40 mm, bill from skull : 45 mm, tarsus : 19 mm, wing : 257 mm, tail (outer) : 104 mm, tail (inner): 60 mm.

No moult recorded.

It required to be fed several times a day although the total quantity eaten was very small (4–5 8 cm long fish approx.). Fish had to be cut into tiny slivers and were taken in narrow end first. Very little water was taken although provided.

Exceptionally tame and accepted food from hand without hesitation. Juvenile feeding or begging posture commonly adopted with head set low over the shoulder and the mouth slightly open. Grew considerably bolder till it flew out of the door on the seventh day and was seen to be pursued by a pair of brahminy kites. No further record of the bird.

I wish to thank the staff of the B.N.H.S. Station, Vedaranyam for help in identification and measurement. Their guidance in various other respects is also gratefully acknowledged.

April 4, 1990 VIVEK MENON

10. *STERNA BERGII THALASSINA* STRESEMANN — AN ADDITION TO THE AVIFAUNA OF SRI LANKA

There is uncertainty about the exact number of subspecies of *Sterna bergii*, the (large) crested or swift tern. Cramp (Chief Ed.) in BIRDS OF THE WESTERN PALEARCTIC lists four, namely :

S.b. velox, which inhabits the coasts of the Indian subcontinent, the Persian Gulf and the Arabian Sea, the Bay of Bengal to Burma and Western Malaysia. It is the largest and darkest.

S. b. thalassina, found in the Western Indian Ocean from about Tanzania to Chagos Island, Madagascar and the Mascarenes. It is the palest.

The nominate *S. b. bergii* is found at the southern end of Africa, in Namibia and S. Africa.

S. b. cristata, the eastern race, occurs from China and Indonesia eastward.

Harrison (1985) adds a fifth: *S. b. enigma*, recently described from Mozambique.

Peters (1937) recognises five, which include *S. b. gwendolenae*. Condon (1975) lists *gwendolenae* for Australia, as well as two more, namely *pelecanoides* and *poliocerca*, bringing the number to eight or more subspecies worldwide. Thus there is not a generally accepted number of subspecies of *Sterna bergii*. Obviously a revision of the species is desirable.

In Sri Lanka the resident *S. b. velox* has dark slate-grey saddle and upperwings, in winter as well in summer. The appearance of these upperparts in the

perching bird is comparable to that of the lesser blackbacked gull *Larus fuscus fuscus*. For many years I have regularly observed a colony of these large crested terns, varying in number from 20 to over a hundred, perching and roosting on rocks just off the sea coast past Colombo Fort. These rocks are often closely packed with terns of several species (eight so far recorded). During the winter months (until the advent of the monsoon in May when they disperse because of high waves), I look at them through a telescope 3 to 4 times a day, more often on weekends. From about the begining of 1990 I noted a strange and different individual amongst them, and since the middle of March, it was always present on the rocks together with up to 100 large crested terns, which had assumed breeding plumage (except for first year birds which look superficially like adults, but can be recognised by the different head pattern and somewhat patchy dark upperwings). The unusual bird stood out from amongst the others by its very pale, chalky-grey upperparts. In flight it looked entirely white. The plumage on the head was that of a first-year large crested tern. On several occasions I noted through a 40x telescope from close vantage positions, the following details in the perching bird:

Size: Notably smaller than the other large crested terns. All parts are proportionately smaller or shorter, e.g. legs and feet, crest, bill.

Head: Shape and general appearance like the others, with a similar but smaller crest. Forehead and fore-crown white, crown and nape streaked brownish-black, feathers on nape brownish, with a loose, untidy crest, often erected in defensive action against neighbouring birds. Crest feathers form dark lines on both sides of rear crown and nape. From eye across to ear coverts to side of nape small streaky pale-brownish patches. Some dark feathers in front of eye, and from eye to sides of crown.

Bill: Shorter and paler than that of other crested terns, very pale yellow, with greenish and horny tint, especially at base.

Upperparts: Lower nape white, saddle and upperwings light chalky grey, with longest outer primaries only slightly darker. Rump and tail same pale grey hue. When tail is spread for preening, dark shafts are visible.

Underparts: White.

Wing: No markings; when folded about same length as tail.

Tail: Chalky grey, forked, with two outer feathers longer and paler.

Legs: Proportionately shorter and thinner than in nearby other large crested terns. Dull black in colour.

Habits: No call noted. The bird seems to have a somewhat faster wing beat than *S. b. velox*. When disturbed from perch by crows, it flies rather low over the water, which it skims on occasion; flies higher on feeding flights. The behaviour (preening etc.) on the rocks is the same as that of the other crested terns. But it affects a defensive attitude toward its close neighbours (erection of crest, constant alertness) and it is often met with some aggressiveness (as a smaller bird?), but not to the extent of driving it away.

The bird could be mistaken for a winter sandwich tern *S. sandvicensis,* except for the pale yellow bill and the smaller size, both not readily noticeable at a distance.

Despite its somewhat shaggy look, the bird is perfectly healthy and capable of looking after itself. Under the circumstances I conclude that it belongs to the Western Indian Ocean subspecies *S. b. thalassina.* This is the first record of this race in Sri Lanka and in the Indian subcontinent, i.e. the Eastern Indian Ocean.

I am greatly obliged to Mrs. Amberley Moore of the British Ornithologists' Club, for the kind assistance with regard to the number and types of subspecies of *Sterna bergii.*

November 18, 1990 THILO W. HOFFMANN

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11. REVIEW OF THE STATUS OF THE SANDWICH TERN *STERNA SANDVICENSIS* IN KERALA

(With a text-figure)

According to Harrison (1985), the major breeding populations of the sandwich tern *Sterna sandvicensis* are those in Great Britain, France, Germany, Denmark and also the shores of Black Sea and Caspian Sea. Wintering birds have been found to disperse to north-west Africa, south to Cape of Good Hope, South Africa, occasionally east to Natal, but are rare off Kenya.

Ali and Ripley (1987) describe the sandwich tern to be a winter visitor in fair numbers to West Pakistan (Makran and Sind coasts). In India, the tern was observed for the first time in Saurashtra, Gujarat (Dharmakumarsinhji 1958). There was subsequently an instance of ring recovery from Kerala in 1976 (Ambedkar 1985). Lal Mohan (1986) reported the recovery of a ringed sandwich tern in Rameswaram island, Tamil Nadu. However, sandwich terns have been shown to winter in substantial numbers fairly regularly along the coast of Gujarat (Mundkur 1987). With this background, the occurrence of the species along coastal Malabar in north Kerala is significant.

I was at Calicut between September 1987 and May 1989 in connection with an ecological study on shorebirds occurring in certain estuaries and such other wetland habitats of coastal Malabar. During the course of the study, I observed that sandwich terns were regular visitors to Kadalundi estuary (Fig. 1) occurring in fairly good numbers (Table 1). Sporadic observations made at the estuary earlier by certain members of the Kerala Natural History Society (Namasivayan, pers. comm.) also indicated that the birds were found in good numbers in 1985 and also in 1986. From September 1987 to May 1989, the observations at the estuary were regular and, therefore, the count more accurate.

The birds found at Kadalundi were among mixed flocks of gulls and terns, comprising usualy brownheaded gulls *Larus brunnicephalus*, blackheaded gulls *Larus ridibundus*, lesser black-backed gulls *Larus fuscus*, whiskered terns *Chlidonias hybrida* and large crested terns *Sterna bergii*, all usually congregated together on intertidal mudflats. When flushed, however, the terns tended to flock separately before settling back on the mudflats after some time. Most of the sandwich terns found at the estuary were in non-breeding adult plumage with white crown streaked with black. The ivory tipped, black slender bill was unmistakable and within the range of the binoculars. Gullbilled terns *Gelochelidon nilotica*, which also appear white during flight and are therefore likely to be confused with the sandwich tern, were sighted only rarely at

TABLE 1
SIGHTINGS OF SANDWICH TERNS AT KADALUNDI (1985–89)

Year	No. of sightings per month											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1985*											35	30
1986*	100	100	100			4						
	100	100	100									
			500									
1987											4	
1988			50	100	6		10		1			1
			20		70							
					47							
					30							
1989	10	50	52		6							
	4		70		8							
	50		100									

* Estimates made by Namasivayan (pers. comm.). Regular data available from September 1987.

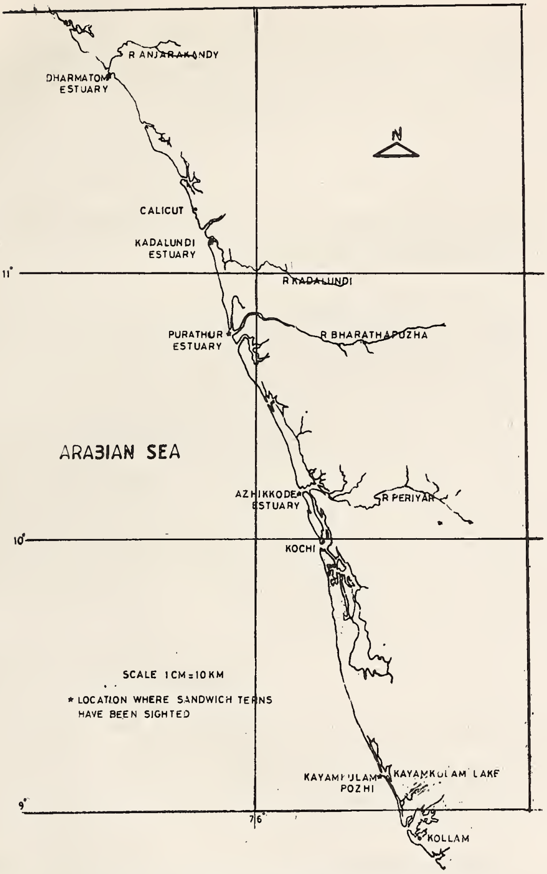

Fig. 1. Locations on Kerala coast where sandwich terns were seen.

TABLE 2
SIGHTINGS OF SANDWICH TERN IN KERALA (1987–90), AT PLACES OTHER THAN KADALUNDI

Site	Date	Number of terns
Dharmatom estuary	1 Dec. 1987	1
Purathur estuary	5 Jan. 1988	2
Purathur estuary	5 Mar. 1988	30
Azhikkode estuary	26 Oct. 1988	56
Kayamkulam estuary	18 Mar. 1990	25

Kadalundi. However, the former species was found in fairly good numbers at Purathur (Bharathapuzha) estuary, approximately 20 km south of Kadalundi (Fig. 1).

A few other estuaries surveyed (Fig. 1) during the period also demonstrated the occurrence of sandwich terns (Table 2). While there was only a single sight record of a solitary sandwich tern at Dharmatom estuary, approximately 150 km north of Kadalundi, at Purathur estuary, the birds were seen on two occasions. At Azhikkode estuary in central Kerala, where river Periyar joins the sea, not less than 56 sandwich terns were observed. In this case, most terns were found perching on the numerous bamboo poles jutting out of the water surface.

In February 1990, Mohan Kumar reported the sighting of sandwich terns at Kayamkulam Pozhi (Fig. 1), where the Kayamkulam backwaters open to the sea. On 18 March 1990, I accompanied him to the area which is 28 km north of Quilon and there, we found at least 25 sandwich terns besides as many gullbilled terns and three large crested terns. This turned out to be the first sighting of the species in south Kerala.

In most instances cited, the areas were not surveyed regularly except at Bharathapuzha and Kadalundi estuaries, and perhaps the sandwich terns may have a far more extensive distribution than it appears. Further, it has been shown that sandwich terns have been regularly visiting Sri Lanka in small numbers (Hoffman 1987).

ACKNOWLEDGEMENTS

I thank L. Namasivayan of the Kerala Natural History Society, Calicut for useful discussions and also for permitting me the use of notes. Thanks are also due to Mohan Kumar who told me about the birds at Kayamkulam, and Dr. V.J. Zacharias, my guide, for his comments.

April 9, 1991

D. K. NARAYANA KURUP

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12. NEW NESTING SITE OF THE INDIAN WHITEBREASTED KINGFISHER *HALCYON SMYRNENSIS FUSCA* (BODDAERT)

The Indian whitebreasted kingfisher *Halcyon smyrnensis fusca* (Boddaert) has been reported to nest in a tunnel bored in the steep bank of a dry nullah or roadside cutting or in the side of a dry ditch, *kutcha* well or borrow-pit. The nest (a horizontal tunnel) size is given as *c.* 7 cm in diameter and from *c.* 50 cm to more than a metre long (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983).

On 24 April 1988 around 1430 hrs I saw a whitebreasted kingfisher coming out of a hole from a hay stack of paddy hay (*c.* 3.5 metres high) situated in the backyard of a house at Mayiladuthurai, Dist. Thanjavur (Tamil Nadu). On examination of the hole I found four eggs of the whitebreasted kingfisher inside. The nest was a horizontal tunnel 10 cm in diameter and 41 cm long, and was situated *c.* 1.8 m from the ground. The nest was made of hay and no other foreign material except the eggs was found inside. Moreover I learnt that kingfishers had nested in similar haystacks at the same site during previous years also. The hay stack can therefore be considered as a new nesting site for the opportunistic whitebreasted kingfisher.

January 3, 1990 P. BALASUBRAMANIAN

13. FEEDING BY COMMON NIGHTJAR *CAPRIMULGUS ASIATICUS* AND INDIAN ROLLER *CORACIAS BENGHALENSIS* IN THE LIGHT OF MERCURY VAPOUR LAMPS

The common Indian nightjar *Caprimulgus asiaticus* is the most abundant and widely distributed nightjar of India. On 29 March 1990 it was noticed feeding on insects attracted by the very bright light of mercury vapour lamps at power sub-station, Bhilai, located in fairly thickly populated area.

An Indian roller *Coracias benghalensis,* already on the hunt since dusk, was joined by a nightjar around 1900 hrs, which appeared with its characteristic almost soundless flight.

The feeding habits of Indian rollers have been described by Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) as "the species has been generally noticed hunting during day time or till late evening". However in this case, it was found hunting insects in the air, in very bright light till 2100 hrs. Similar instances of Indian roller feeding at lights have been recorded by me on 31 March 1989 (1830 hrs), 12 April 1989 (1900 hrs.), 4 July 1989 (1945 hrs), 22 April 1990 (2130 hrs) and on 8 April 1990 (2230 hrs). On most of these occassions it was feeding amongst a busy traffic area. Interestingly, black drongo *Dicrurus adsimilis* was also foraging. The latter species has already been recorded feeding by the light of street lamps (Jamdar 1983, *JBNHS 80*: 218).

June 25, 1990 A. M. K. BHAROS

14. POSSIBLE OCCURRENCE OF THE GREY SHRIKE *LANIUS EXCUBITOR* LINN. IN ASSAM

On 8 February 1990 on the banks of the Brahmaputra river in Lakhimpur district of Assam, I saw a shrike perched on a narrow branch on top of a hedge in the scrub jungle of the river bank. It was

larger than the brown shrike *Lanius cristatus* and had light slaty-grey upperparts, the underparts being dull white. The black band across the eye to the ear-coverts (typical of most shrikes) was not fully developed, and was slightly deeper-grey than the head and the upperparts. This may be due to the fact that the bird was perhaps an immature. I observed the bird for a few minutes till it flew beyond the hedge.

It was undoubtedly a shrike and resembled closely the grey shrike *Lanius excubitor*. If it was the grey shrike, then this is the first record in Assam. Location was on the banks of the Brahmaputra river, near Matmora (13 km from Dhakuakhana, the Subdivisional Headquarters) in Lakhimpur district. The grey shrike is a bird of comparatively drier environs and is found up to Bihar and West Bengal (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983). The easternmost recorded locality so far was Kushtia (*c.* 23° 54' N, 89° 07' E), Bangladesh (SYSTEMATIC LIST OF BIRDS, Rashid 1967). The present locality may thus be the easternmost distribution (27° 10' N, 94° 33' E) .

April 5, 1990 ANWARUDDIN CHOUDHURY

15. BREEDING BIOLOGY OF THE MALABAR WOODSHRIKE *TEPHRODORNIS VIRGATUS SYLVICOLA* JERDON AT THEKKADY, KERALA

The present data, collected during an intensive study on the ecology of drongos (Vijayan 1984, Ph.D. thesis, Univ. of Bombay) under the supervision of the late Dr. Salim Ali, provide details on the nesting of this species at Thekkady in the Periyar Tiger Reserve (9° 15' to 9° 40' N and 76° 05' to 77° 25'E) in Kerala during 1981. The study area was of about 150 ha of moist deciduous/ semi-evergreen forest patch with low-lying grasslands on either side.

Nesting season: The nesting season extends from January to April. Six pairs were observed breeding in the study area. Renesting was noticed in all pairs except the one in which the first clutch was successful. Therefore, in all, 12 nests were observed, of which two were in January, nine in February and one in March. The successful pair had fledgelings in March-April.

Nesting tree, height and location: Teak *Tectona grandis* and terminalia *Terminalia paniculata* were used for nesting. Among the 12 nests observed, seven were on the former and five on the latter. Nesting height varied from 8 to 13 m with an average of 10 m (Table 1). Location of the nest was on the top of a horizontal branch, at the base of the main stem or a branch.

Nest, nest building and clutch size: The nest is a shallow cup of spider webs, moss, lichens, pieces of bark, and a few thin fibres as a lining at the bottom. Only the slightly raised rim of the nest could be seen from below as it was well camouflaged by the stem of the tree and the colour of the bird. Nest building took about 8 to 12 days for the first nest and was of a shorter duration while renesting. Of the 12 nests, only in seven was the two egg clutch complete (Table 1).

Incubation and nesting success: Except for two clutches, all the others were predated during the incubation period which was 15 and 16 days in the two cases observed, from which only one was successful in producing two fledgelings. The nestling period was 17 days. One nest was deserted as the first egg was preyed on the day it was laid. Four nests were destroyed even before laying. Hatching success was 26.6% and nesting success 13.3%, the productivity being 0.33 young per pair. The fledgeling period and fledgeling success could not be

TABLE 1

NESTING DETAILS OF THE MALABAR WOODSHRIKE AT THEKKADY DURING 1981

Nesting tree	No of nests	Nesting height in m± SD	Clutch size	Incubation period (days)	Nestling period (days)
Tectona grandis (Teak)	7	10.1 ± 1.8	2	15	—
Terminalia paniculata (Terminalia)	5	9.8 ± 0.8	2	16	17

recorded as the fledgelings were not followed.

This study was supported by the Salim Ali-Loke Wan Tho Research Fellowship from the BNHS. Thanks due to Dr. V.S. Vijayan for his encouragement and also for going through the manuscript.

June 8, 1990 LALITHA VIJAYAN

16. WINTERING RANGE EXTENSION FOR THE RUBYTHROAT *ERITHACUS CALLIOPE*

Place of ringing	Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)	Weight (g)
Tirumala Hills	73	16	28	62	20
Point Calimere	76	19	29	63	23

The rubythroat *Erithacus calliope* is an uncommon winter visitor to the Indian subcontinent, mostly to its north-eastern and eastern parts. In south India they are known to reach only up to Godavari delta in north-eastern Andhra Pradesh where they are fairly common only in Hailakandi and Visakhapatnam (17° 30'N, 83° E) districts (HANDBOOK OF BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983).

A male rubythroat was trapped and ringed on 3 February 1990 at Point Calimere Wildlife and Bird Sanctuary (10° 18' N; 79° 52'E) in Tamil Nadu. This is the first confirmed record of rubythroat for the state and the southern most record. It is interesting to note that another male rubythroat was ringed at Tirumala Hills (13° 40' N, 79°20 E) in southern Andhra Pradesh on 21 November 1989 and even that was further south to its known wintering range in India. Since the birds were caught in November and February it is quite likely that the species is not just a passage migrant but a sporadic winter visitor to south India as well.

The measurements (mm) and weight (g) of the birds are as shown above.

S. BALACHANDRAN
LIMA ROSALIND
March 29, 1990 S. ALAGAR RAJAN

17. PLUMAGES, FEMALE DIMORPHISM AND POLYMORPHISM OF THE ENDEMIC INDIAN SPECIES *PARUS XANTHOGENYS*

(With a colour plate)

There appears to be some confusion and controversy regarding the plumages of the *Parus xanthogenys* group. A black crest and a longitudinal black band from chin to vent, is usually described as being the adult plumage common to both sexes. Whistler and Kinnear (1931, *JBNHS 35:* 520) examined the series collected by La Personne and reported an interesting problem regarding the plumages of this genus. 15 males agreed with the description, but the three females and an unsexed bird differed in having the black ventral band replaced by dull olive green. They concluded that either the sexes differ or the bird takes a year to assume adult plumage. After examining the Eastern Ghats survey birds they stated that the peninsular Indian race *aplonotus* and the Western Ghats race *travancoreensis* have their sexes different. They described three types of females for the race *travancoreensis*. 1. Black head and black band, 2. Black head and green band and 3. Green head and green band.

Salim Ali (1940, *JBNHS 41:* 86) says the females were dimorphic in *aplonotus*. Phase 1. crown and eye-streak black, ventral stripe dull olive green; Phase 2. crown and eye-streak dull olive green, ventral stripe dull olive green. For *travancoreensis*, he said adult male and female were not alike. Male: crown black, ventral stripe black. Female: crown

Parus xanthogenys travancoreensis
Left: **juvenile,** ***Centre*****: moulting,** ***Right:*** **adult**

black, ventral stripe dull olive green. Juveniles not alike but resembling their respective adult. There seems to be a mix up of names in this case, since Ali goes on explaining about a Nilgiri bird under *aplonotus.* He might have been describing dimorphism in *travancoreensis* females and not in *aplonotus.*

Salim Ali (1942, *JBNHS 43:* 146) states the possibility of *aplonotus* females being dimorphic since he had seen birds indistinguishable from adult males and marked females; and those of *travancoreensis* as polymorphic. Phase 1. similar to adult male, black crown and black ventral stripe; Phase 2. as in *aplonotus* crown black, ventral stripe dull olive green; Phase 3. crown dull olive green, ventral stripe dull olive green. Juveniles not alike: male similar to the adult, female crown black and ventral stripe dull olive green. He doubted the second and third phases and said they required fresh verification.

Charles Vaurie (1950, Amer. Mus. Novitates no. 1459, p. 40) states that he and Dr. B. Biswas had gone through all the statements made by Whistler in his various papers and examined specimens collected by Koelz and those in the collection of the American Museum. He concluded that the polymorphism of adult females in true *travancoreensis* is not established. Unfortunately they had seen only three specimens of *travancoreensis,* two adult males and one adult female and none in the juvenile stage.

Salim Ali and Dillon Ripley (1973, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN vol. 9, pp. 189-190) do not mention the dimorphism in *aplonotus* but repeat that the females of *travancoreensis* are polymorphic.

After going through the literature and critically examining the 74 specimens of the races of this species (45 males, 21 females and 8 unsexed) in the BNHS collection I am in a better position to describe the plumages of the different races and comment on the disputed dimorphism and polymorphism of the females. My observations are as follows.

Parus xanthogenys xanthogenys Vigors

18: 11 males (1 juv.) 3 females 4 unsexed

Paler and brighter. The males have black crown, black ventral stripe, long bright yellow supercilium, and tips of wing coverts almost white (yellow might have faded into white in the skins). There is not much difference between males and females in this race. The females also have black crown, black chin and ventral stripe. Even the size of the crest is more or less the same. The four unsexed specimens cannot be separated by plumage. The single juvenile we have is a male (Simla, 26.9.26), slightly smaller with a short crest and the tips of the wing coverts are yellowish.

Parus xanthogenys aplonotus Blyth

33: 17 males 13 females 3 unsexed

Darker and duller. Both males and females have black crown and the tips of wing coverts white. The ventral stripe in the male is black and in the female it is olive green. The females have a shorter crest.

A specimen from Saugar, C. P. (23.2.1899) though marked male is in female plumage, and might be wrongly sexed. Out of the three unsexed specimens, one from Lonawala (Aug. 1875) is a male by plumage. The other two, from Sankrametta, Vizag (4.3.1930) and Sehore, C. I. (Jan. 1914) are females by plumage.

There is no evidence for dimorphism in the females as stated by Salim Ali. All the females are with black crown and olive green ventral stripe and none in the latter being black. The specimens he saw in the latter plumage were probably wrongly sexed ones.

Parus xanthogenys travancoreensis
(Whistler & Kinnear)

23: 17 males 5 females 1 unsexed

Dullest of the three races, larger in size than the other two, white tips of the wing coverts and rectrices smaller. The males are with black crown and black ventral stripe. In the adult female there is hardly any crest, the feathers of the crown are like back, dull greyish olive but with dark centres and shafts. Freshly moulted specimens are with olive green crown with prominent dark centres and shafts. As they age the olive green turns into greyish olive with less marked centres and shafts. The ventral stripe is pale and hardly distinguishable from the dull yellow-tinged grey underparts.

Two females, one from Santanpara, Cardamom Hills (26.1.1933) marked immature and another from South Konkan (23 March 1879) marked juvenile

have black heads. One female from Mysore (20.1.1940) has the forehead and anterior part of the crown olive green with prominent dark centres and shafts to the feathers and the rest black. A female from Palni Hills (10.5.1956) and another from Nilgiris (20.2.1943) have their crown concolorous to the back, e.g. greyish olive.

One specimen from Castle Rock, Kanara (10.10.1912) marked male is a juvenile female with a black crown. The unsexed specimen from Shembagnur, Palni Hills (1958) is an adult female by plumage with greyish olive crown and back.

There is no evidence for polymorphism in females of this race as stated by Whistler and Salim Ali. Since both the females with black heads are marked juveniles it is suggested that this is a stage before the post juvenile moult. This is confirmed by the fact that we have a female specimen with a crown half olive and half black, in the process of moulting, the black crown of the juvenile female being replaced by the adult olive green. I come to the conclusion that phase 1 females with black crown and black ventral stripes are wrongly sexed specimens, phase 2 with black crowns and olive green ventral stripes are juveniles and phase 3 with olive green crowns and olive green ventral stripes are the actual adult females of this race.

From the northern Himalaya to southern Travancore, there is a cline of gradually decreasing brightness in the plumage of this species; *xanthogenys*, the northernmost nominate race with brightest yellow and olive green in their plumage, the central *aplonotus* less bright, or dull green and yellow and the southern most *travancoreensis* being much duller with the mantle almost lacking green and being greyish, the yellow very pale and the adult females all being grey with only a slight tinge of yellow below. As far as sexual dimorphism is concerned southern *travancoreensis* with its entirely different sexes tops the three. In *aplonotus* the difference between the sexes is only in the colour of the ventral stripe and in the northern *xanthogenys* the sexes are almost same. The size of the crest also follows this pattern. In *xanthogenys* the size of the crest is more or less the same in both sexes, *aplonotus* females have a shorter crest than the male and *travancoreensis* females have hardly any crest.

I am indebted to Humayun Abdulali, my 'Guru' in ornithology, for going through the manuscript.

February 21, 1992 S. UNNITHAN

18. INTERESTING FEEDING PATTERN OF YELLOWTHROATED SPARROW *PETRONIA XANTHOCOLLIS* (BURTON)

Amongst various species of birds observed feeding on mahua *Madhuca indica* flowers were yellowthroated sparrows *Petronia xanthocollis*. Their feeding pattern was rather interesting.

A juicy flower was plucked and carried to a nearby thick branch, placed on rough bark for a while, and then dragged backwards for about 50 cm with downward pressure applied with the beak. The partly battered flower was picked up, again placed about 30 cm ahead and dragged back. This act was repeated three or four times till the flower was almost reduced to fragments, which were then eaten. Thereafter, another flower was plucked and the entire act repeated.

Inability of the species to swallow the whole flower could be the reason for adopting the above feeding pattern.

April 1, 1990 A.M.K. BHAROS

19. 'BLIND' NEST OF BLACKTHROATED WEAVER BIRD *PLOCEUS BENGHALENSIS* (LINN.)

'Blind nests' (i.e. abnormal nests without an entrance) are sometimes prepared by weaver birds. The phenomenon has been described by Davis (1985, *JBNHS 82(3):* 658-660) in baya weaver bird *Ploceus philippinus*. This tendency also occurs in the blackthroated weaver bird *Ploceus benghalensis*.

During the breeding season of 1989, in the river bed of Nahawani river near Harsora dam in Alwar

district, I located an equally vast colony of *P. benghalensis* in the dense clumps of *Saccharum bengalense,* hardly 3 km away from the dam, towards the northern side. Hundreds of adult males of *P. benghalensis* were nesting there. They were readily identified by the colouration of their golden-yellow crowns and streakless breasts. In the vicinity of this 'adult colony' I located an approximately 2 ha. area where exclusively yearling cocks were nesting. While observing their nests one by one, I came across a nest of one yearling cock, having no entrance hole. Its upper half was slender but the lower half was massive and spherical. A slight bend was present between the two halves. The fibre used for fabricating the nest was that of *Saccharum bengalense.*

The nest was removed from the clump and cut open. It was noticed that the internal cavity was extremely small. Neither any deposition nor any beautifying material was present inside.

The whole breeding site was surveyed, but no other 'blind' nest was found in the colony. Others were normal though appearing crude.

The tendency of making blind nests is not seen in adult cocks of *P. benghalensis* anywhere in eastern Rajasthan, though it is apparently expressed by adult *P. philippinus* in the area. In the present case it seems likely that making a blind nest by a yearling bird was due to lack of experience in nest fabrication.

April 8, 1990 SATISH KUMAR SHARMA

20. SPOTTED MUNIA *LONCHURA PUNCTULATA* (LINN.) FROM DACHIGAM NATIONAL PARK, JAMMU AND KASHMIR

A male specimen of the spotted munia *Lonchura punctulata* was caught during mist netting on 21 June 1989, in Dachigam National Park (34° 96'N, 74° 51'E; alt. 1650 m), Jammu and Kashmir.

Its biometrics were as follows: wing 57 mm, bill 12 mm, tarsus 15 mm, tail 44 mm. It was an adult bird with a developing brood patch. The bird was trapped in a rocky area dominated by medium sized scattered bushes of *Indigofera heterantha* and *Prunus arvenica,* with thin grass cover. The bird was ringed (Ring No. A: 210661) and released. Its distribution is recorded as east of a line roughly joining Madhupur (Jammu), Ludhiana, Sambar Lake, Mt. Abu, southern Kathiawar, eastwards along the lower Himalayas to Bhutan and Bangladesh and south to Kanyakumari and Sri Lanka. The present record confirms the earlier report of Holmes and Parr (1988, *JBNHS 85:* 465-73) of a singleton from Haigam Rakh, Kashmir. The range of the species may thus be extended northwards to the Kashmir valley.

S.A. AKHTAR
PRAKASH RAO
J.K. TIWARI
January 18, 1991 SALIM JAVED

21. AN UPDATED LIST OF BIRD AND BAT SPECIES INVOLVED IN COLLISION WITH AIRCRAFT IN INDIA

The BNHS has been assisting the Indian Air Force and Civil Aviation Ministry by providing identification of bird species involved in collisions with aircraft through examination of bird-strike remnants since 1966. The bird- and bat-strike remnants were identified at BNHS by several researchers, namely D.N. Mathew, Robert B Grubh, Saraswathi Unnithan, Lima Rosalind, S.M. Satheesan and R.J. Pimento.

Bird strike remains obtained from aerodromes were compared with specimens in the BNHS reference collection. For microscopical examination dry mounts of downy barbs of feathers from remnant samples were compared with similar slides prepared from known species of birds. The techniques given by Brom (1980, 1986), Brom and Buurma (1979), Laybourne (1984, 1986) and Rosalind and Grubh (1987) were used for microscopic studies. In most cases where at least one feather was available intact, the identification was confirmed by comparison with an identical feather from a bird specimen from the BNHS collection. It was not possible to identify birds

down to the species level with microscopic method alone. The findings of Ali and Grubh (1984), Grubh (1988) and Satheesan (1990) were referred to prepare this updated list of bird and bat species involved in collision with aircraft from 1966 to 1989.

Sixty seven species of birds and three species of bats were identified from 360 samples of remnants received from Indian aerodromes after reported collision with aircraft from 1966 to 1989. The species are listed in Table 1.

S.M. SATHEESAN
ROBERT B. GRUBH
REX J. PIMENTO

March 8, 1990

TABLE 1

BIRD AND BAT SPECIES INVOLVED IN COLLISIONS WITH AIRCRAFT

		Approx. wt in g	Percentage of incidence (n = 360)
(A) **Birds**			
1.	Pond heron *Ardeola grayii*	215	0.28
2.	Cattle egret *Bubulcus ibis*	450	1.11
3.	Little egret *Egretta garzetta*	400	0.28
4.	Night heron *Nycticorax nycticorax*	275	0.28
5.	Bittern *Botauarus stellaris*	900	0.28
6.	Pintail *Anas acuta*	700	0.28
7.	Comon teal *Anas crecca*	300	0.28
8.	Blackwinged kite *Elanus caeruleus*	270	1.11
9.	Pariah kite *Milvus migrans govinda*	680	20.28
10.	Blackeared kite *Milvus migrans lineatus*	750	0.56
11.	Brahminy kite *Haliastur indus*	600	1.11
12.	Sparrow-hawk *Accipiter nisus*	200	0.28
13.	Longbilled vulture *Gyps indicus*	5000	0.56
14.	[a]Whitebacked vulture *Gyps bengalensis*	4500	20.28
15.	Indian scavenger vulture *Neophron percnopterus*	2000	0.83
16.	Montagu's harrier *Circus pygargus*	250	0.56
17.	Pale harrier *Circus macrourus*	300	0.28
18.	Marsh harrier *Circus aeruginosus*	400	0.28
19.	Short-toed eagle *Circaetus gallicus*	1500–2000	0.28
20.	Redheaded merlin *Falco chicquera*	225	0.28
21.	Kestrel *Falco tinnunculus*	125–150	0.28
22.	Black partridge *Francolinus francolinus*	400	0.28
23.	Rain quail *Coturnix coromandelica*	75	0.56
24.	Painted bush quail *Perdicula erythrorhyncha*	80	0.28
25.	Indian peafowl *Pavo cristatus*	4000	0.28
26.	Demoiselle crane *Anthropoides virgo*	2500	0.28
27.	Painted snipe *Rostratula bengalensis*	125	0.28
28.	Blackwinged stilt *Himantopus himantopus*	170	0.28
29.	Stone curlew *Burhinus oedicnemus*	380	1.94
30.	Large Indian pratincole *Glareola pratincola*	125	0.28
31.	Small Indian pratincole *Glareola lactea*	40	0.56
32.	Redwattled lapwing *Vanellus indicus*	190	0.28
33.	Yellow-wattled lapwing *Vanellus malabaricus*	110	0.28
34.	Eastern golden plover *Pluvialis dominica*	103	0.28
35.	Gull *Larus* sp.	116–405	0.28
36.	Sooty tern *Sterna fuscata*	200	0.28

[a]Unidentified vultures (*Gyps* sp.) — 4.44%

		Approx. wt in g	Percentage of incidence (n = 360)
37.	Indian sandgrouse *Pterocles exustus*	250	1.11
38.	Yellowlegged green pigeon *Treron phoenicoptera*	250	0.56
39.	Blue rock pigeon *Columba livia* domestic, feral & wild	300	7.78
40.	Ring dove *Streptopelia decaocto*	130	1.39
41.	Red turtle dove *Streptopelia tranquebarica*	90	0.28
42.	Spotted dove *Streptopelia chinensis*	125	2.5
43.	Little brown dove *Streptopelia senegalensis*	80	0.83
44.	Roseringed parakeet *Psittacula krameri*	120	1.11
45.	Koel *Eudynamys scolopacea*	160	0.28
46.	Spotted owlet *Athene brama*	120	0.28
47.	Great horned owl *Bubo bubo*	1100	0.28
48.	European nightjar *Caprimulgus europaeus*	75–100	0.28
49.	Swiftlet *Collocalia* sp.	15	0.56
50.	[b]House swift *Apus affinis*	20	5.28
51.	Palm swift *Cypsiurus parvus*	18	1.39
52.	Kashmir roller *Coracias garrulus*	170	0.28
53.	Indian roller *Coracias benghalensis*	170	0.56
54.	Short -toed lark *Calandrella cinerea*	20	0.56
55.	Crested lark *Galerida cristata*	28	0.28
56.	[b] Common swallow *Hirundo rustica*	18	0.28
57.	Indian cliff swallow *Hirundo flavicola*	9	0.28
58.	Redrumped swallow *Hirundo daurica*	18	1.11
59.	Rufousbacked shrike *Lanius schach*	25	0.28
60.	Starling *Sturnus vulgaris*	60–80	0.28
61.	Common myna *Acridotheres tristis*	110	1.67
62.	Pied myna *Sturnus contra*	75	0.28
63.	House crow *Corvus splendens*	300	1.11
64.	Jungle crow *Corvus macrorhynchos*	500	0.28
65.	Bluethroated flycatcher *Muscicapa rubeculoides*	15	0.28
66.	Longtailed warbler *Prinia* sp.	5-8	0.28
67.	House sparrow *Passer domesticus*	25	0.28
(B)	**Bats**		
68.	Indian pigmy pipistrelle *Pipistrellus mimus*	20	0.56
69.	Tomb bat *Taphozous* sp.	25	0.28
70.	Flying fox or giant fruit bat *Pteropus giganteus*	600	0.56

[b]Unidentified swifts and swallows — 1.39%.

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22. GUT CONTENTS OF A MUGGER *CROCODYLUS PALUSTRIS*

The mugger *Crocodylus palustris* is widely distributed in India. A number of workers reported that muggers mostly feed on fish, aquatic beetles, bugs, molluscs, frogs, water snakes, birds, pig, goat and occasionally on human and vegetable matter (Abdulali 1938, D'Abreu 1915, Krishnamurthy 1951, McCann 1935, Simox 1905). We report here on the gut contents of a mugger which escaped from a semi-captive condition at Vanvihar near Dholpur, Rajasthan and died after one year under mysterious circumstances in the Urmila Sagar lake, 3 km from Vanvihar.

On 6 July 1988 we were asked by the officials of the Rajasthan State Forest Department at Dholpur to examine a dead mugger. We found the dead mugger floating in the lake. The total length of the animal was 2.66 m. The right side of the snout was broken, by which it was identified as originating from Vanvihar. The mugger was badly decomposed by the time we saw it. No external injury was evident. The internal organs were decomposed but we found bones, pieces of carapace and the lower jaw of a softshell turtle, in its alimentary canal. The turtle was indentified as a pond turtle *Lissemys punctata.* The size of the turtle (carapace length) was calculated to be about 20 cm from the carapace pieces. Other gut contents removed from the body were broken portions of water beetle, crab, a few small stones and pieces of aquatic vegetation.

Water bodies in and around Dholpur city have large populations of pond turtles. They become active during monsoon after their long aestivation and during this period they are easy prey to the mugger.

R.J. RAO
S.A. HUSSAIN

September 10, 1991

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23. UNUSUAL NESTING SITE OF MUGGER *CROCODYLUS PALUSTRIS* IN MADHAV NATIONAL PARK

Sakhya Sagar Lake (25° 26' N, 77° 42' E) is situated in the central zone of Madhav National Park (24° 55'- 25° 55' N and 77° 15' - 78 ° 30'E) in Shivpuri district of Madhya Pradesh. From the main gate of the central zone, a road runs on the elevated land along the southern bank of Sakhya Sagar, for about 200 m up to the sailing Club House inside the national park.

In January and February 1991, many holes were dug for tree plantation along this road. The diameter and the depth of each hole were 60 cm. On 15 June 1991, the forest staff saw a crow feeding on some eggs on the road. On investigation, 31 eggs of the

mugger *Crocodylus palustris* were found in one hole which was dug for plantation. Broken pieces of a few eggs were scattered nearby and the hole was partially covered by soil. This hole was situated at a distance of 15 m and at an elevation of 4 m from the waters of Sakhya Sagar. Earlier an adult mugger had been seen on the road many times. This was an unusual nesting site not only because of egg laying in a hole meant for tree plantation but also because of the high level of disturbance, with a large number of vehicles and men moving along the road from dawn to dusk.

Seven hatchlings came out of the eggs on 17 June 1991 and they were released into Sakhya Sagar on 24 June 1991. Eight more eggs hatched on 29 June and hatchlings were released on 5 July. One hatchling among those released was found on the bank on 13 July 1991. It was again released into the water on the same day.

This is also the first time that successful breeding of mugger has been recorded in Madhav National Park, although I have frequently seen them swimming or basking since 1984. In January 1988, eight muggers basking at different locations were sighted within two hours.

September 16, 1991 RAJIV SAXENA

24. SWALLOWING OF PREY 'LEG FIRST' BY THE COBRA *NAJA NAJA*

On 6 August 1990, at about 0930 hrs, I was walking along a seasonal nulla near village Mohammadpur (Alwar district). I noticed the upper body of a large sized rat (*Tatara indica?*) protruding from a hole in the bund of a field. It remained motionless even after my close approach. I observed the animal carefully and found it dead. Its eyes were bulging. Soon I noticed that due to my presence, something was pulling the dead rat inside the hole. I grasped the head and tried to pull the rat out of the hole, but succeeded only in pulling it out a few centimetres. I found that the other end was being held by an Indian cobra *Naja naja*, which was swallowing the rat tail end first.

Cases of swallowing feet first among Indian snakes have been reported earlier by Mundkur (1985, *JBNHS 82(3):* 676-77) in rat snake *Ptyas mucosus* and by Gay (1978, *JBNHS 75(3):* 854-59) in green keelback *Macropisthodon plumbicolor.* With the present observation, Indian cobra may be included in the list of "back first" swallowing snakes.

January 7, 1991 SATISH KUMAR SHARMA

25. FIRST RECORD OF *UPERODON SYSTOMA* FROM RAJASTHAN

A tree park, the World Forestry Arboretum has been set up near the Jhalana hills, just on the outskirts of Jaipur city by the Forest Department of Rajasthan. The Arboretum covers about 1,000 ha of forest area of the Jhalana hills (Reserve Forest Block No. 92).

Between 21 and 24 August 1990, a survey was conducted of the amphibian fauna present in the Arboretum. For this purpose all the frogs and toads, present in the 24 cemented tanks of the Arboretum (Part A) were captured for counting and identification (Table 1).

As many as eight species of amphibians, namely *Bufo melanostictus, B. stomaticus, Microhyla ornata, Rana cyanophlyctis, R. hexadactyla, R. limnocharis, R. tigerina* and *Tomopterna breviceps* have been recorded from Rajasthan (Inger and Dutta 1986, Dutta 1988, Sharma 1990, Mansukhani and Murthy 1964). *Uperodon systoma* is recorded for the first time in Rajasthan. One individual was captured

TABLE 1

STATISTICS OF AMPHIBIANS BAGGED FROM THE WORLD FORESTRY ARBORETUM, JAIPUR

Species	No. of individuals collected	% of total
Bufo melanostictus Schneider	15	11.62
B. stomaticus Lutken	29	22.48
Rana cyanophlyctis Schneider	7	5.42
R. tigerina Daudin	12	9.30
Tomopterna breviceps (Schneider)	65	50.38
Uperodon systoma (Schneider)	1	0.77
Total	129	

on 24 August 1990 at about 1130 hrs from an aquatic vegetation tank with luxuriant growth of *Nymphaea stellata* and *Hydrilla verticillata*. The specimen was captured when it was sitting on a leaf of *Nymphaea stellata*. The colour pattern was dorsally with irregular spots of black and yellow colour somewhat resembling the colour pattern of a panther's coat. Ventrally: throat and belly creamish yellow-white in colour. Lateral sides yellow.

Snout semi-circular, body slimy and smooth. Snout to vent length was 55 mm and eye to eye width of head was 11 mm. Like *Tomopterna breviceps*, large and shovel-shaped inner metatarsal tubercle was characteristic. Whenever it was lifted it inflated its belly like a balloon.

Besides recording *U. systoma* in Rajasthan, it is worthy to note that *Tomopterna breviceps* (*Rana breviceps*), which is not recorded from Jaipur district, occurred in the Arboretum. Mansukhani and Murthy (1964) have recorded this species only from Jodhpur, Nagaur and Udaipur districts. During an exhaustive survey around Jaipur city, it was collected outside the Arboretum also. A few specimens were collected from cement tanks near Chulgiri Temple on National Highway No. 11.

I thank Dr. Sushil K. Dutta, Utkal University, Bhubaneswar, for identifying the *Uperodon systoma* and providing information about the species, and A.K. Sarkar, Zoological Survey of India, Calcutta, for identification of *Tomopterna breviceps* and *Bufo stomaticus;* Dr. K.K. Sharma, Dept. of Zoology, University of Rajasthan, for encouragement, and my children, Manju, Lalita and Rajesh, who collected most of the frogs and toads including *U. systoma.*

January 7, 1991 SATISH KUMAR SHARMA

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26. ADDITIONS TO THE LIST OF AMPHIBIAN FAUNA OF GOA

Abdulali and Sekar (1988) reported some amphibian species, including *Rhacophorus malabaricus,* the Malabar gliding frog, from Goa. In July 1989, I collected amphibia from different places in Goa. Species which have not been reported earlier are listed.

Uperodon globulosum (Gunther, 1864)

1 adult male and 1 adult female (Sanguem). 67.3 mm SVL, 22.4 mm tibia in male. 73.0 mm SVL, 27.8 mm tibia in female. A fold of skin across the shoulder just behind the eyes in both male and female. A median vertebral groove from the skin fold to the vent prominent in female and indistinct in male. Dorsally grey and smooth, dirty white below and smooth. Throat black in the male.

Both the male and female were collected from short grass near a rain water pool. The male was calling sitting at the edge of the pool. The call was nasal, loud and can be syllabilised as *oink-oink-oink.* It was very wary and stopped calling even on the slightest movement of the observer. The female which had matured, pigmented, ova was collected while moving towards the male.

Rana keralensis Dubois, 1980

2 subadult males and 1 adult female (Volpoi). 32.5 and 33.0 mm SVL, tibia 18.8 and 20.8 mm in males. 43.8 mm SVL, tibia 29.6 mm in female. The description by Boulenger (1920) fits the present collection. Tibio-tarsal articulation reaching between the nostril and the eye. Lips with dark vertical bars. The triangular mark between the eyes and an inverted W-shaped mark between the shoulder present in all three specimens. Dorsally brown with darker spots. Ventrally white. Thighs barred.

All the specimens were collected from the bank of a stream in moist deciduous forest. Daniel (1975)

collected this species from the banks of small, fast flowing hill streams. According to Annandale (1915) this species is abundant in the Travancore Hills.

Rana malabarica Tschudi, 1838

1 adult female (Cotigao). 54.5 mm SVL and 26.9 mm tibia.

This specimen was collected in the open country during rain. Daniel (1975) has also reported that this species preferred forested land though it has been recorded in open country particularly in the breeding season.

Rana tigerina Daudin, 1802

12 juveniles (2 Sanguem, 8 Molem, 2 Cotigao). 19.2-35.0 mm SVL, 9.0-18.1 mm tibia. The vertebral streak is very thin but the lateral band from behind the eye is very prominent. Body green above with dark brown spots and markings and pale white below. Toes fully webbed.

All the specimens were collected from grass fields in different localities. The green body colour matched the green of the grass.

Rana syhadrensis Annandale, 1919

8 adult males and 3 adult females (4 males Volpoi, 4 males Cotigao, 3 females Cotigao). 18.7-20.75 mm SVL, mean 19.53; tibia 8.0-9.65 mm, mean 8.86 in males. 24.05-24.4 mm SVL, mean 24.18; tibia 9.90-10.45 mm, mean 10.17 in females. According to Annandale (1919) this is a dwarf race of *Rana limnocharis.* The specimens from Goa closely agree with his description. Hindlimbs short. The first finger hardly extends beyond the second. Toes slightly webbed, less so than in *Rana limnocharis.* The tibio-tarsal articulation reaches the tympanum or posterior border of the eye. A narrow pale mid-dorsal line present. Dorsal surface dark brown with broken longitudinal glandular folds. Ventral surface white. Thighs barred. In all the specimens the lips are pale white without any dark vertical bars. In this respect they differ from *Rana limnocharis.* Throat black in males. Females with matured pigmented ova.

All the specimens were collected from grass fields with rain water pools in association with *Rana limnocharis* and *Microhyla ornata.* The call was totally different from that of *Rana limnocharis,* resembling the bleating of sheep.

February 11, 1991 A.G. SEKAR

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27. NEW RECORD OF A CROAKER, *JOHNIUS COITOR* (HAMILTON-BUCHANAN) (PISCES: SCIAENIDAE) FROM TRIPURA, NORTH-EAST INDIA

(With a text-figure)

During the course of systematic studies on the fish fauna of Tripura, a specimen of a croaker fish was collected from the river Gumti, Tripura. On examination, it proved to be a specimen of *Johnius coitor* (Hamilton-Buchanan). A perusal of existing literature on the fish fauna of north-eastern India including Datta (1977), Lipton (1983-84), Sen (1985), Bhattacharya (1988) and Barman (1988) shows that this fish is not yet known from Tripura or from the other north-eastern states Therefore, the presence of this fish in the rivers of Tripura, extends its range of distribution to north-east India.

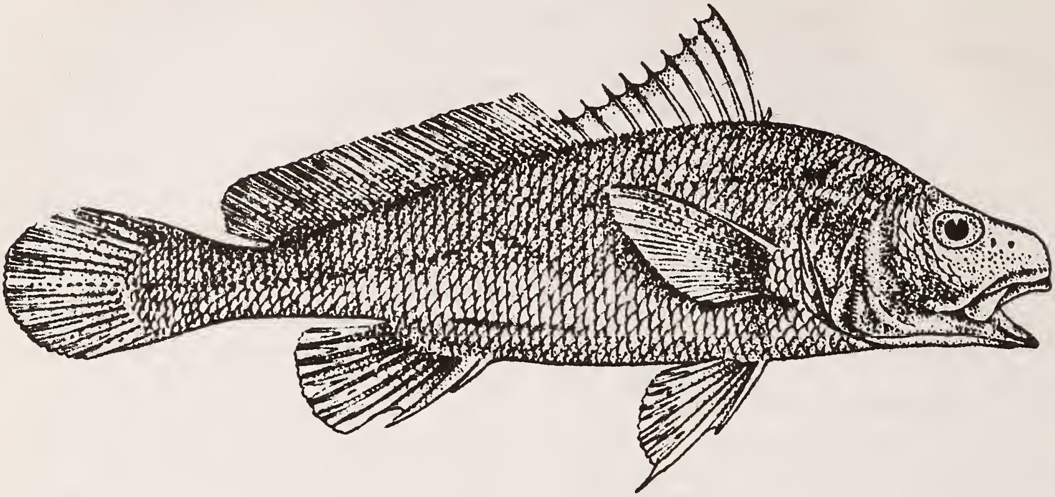

Fig. 1. *Johnius coitor* (Hamilton-Buchanan)

A brief description of the species is given below along with an illustration.

1822. *Bola coitor* Hamilton-Buchanan, *Fish. Ganges*: 75, 368, pl.27, fig. 24 (type-locality : River Ganges).

1876. *Sciaena coitor*, Day, *Fish. India:* 187, pl. 44, fig. 3; 1889. Day, *Fauna Br. India. Fish 2*: 115-116, fig. 49.

1981. *Johnius coitor*, Jayaram, *Handbk. Freshw. Fish. India*: 327 (distribution).

Local name: Bola. **English name:** Croaker.

Material examined: 1 ex., 140 mm SL.; Gumti river, Udaipur, south Tripura; N.C. Ghose: 3 November 1989.

Diagnostic features:

D. 10/1-2/26-29, A.2/7, LL. 48-51

Head length 4.25 to 4.75 and body depth 4.50 to 4.75 in total length. Eye diameter 4.00 to 5.50 in head length. Upper jaw slightly longer. Swim bladder hammer-shaped anteriorly and laterally expanded in front of a strongylation (hammer-headed); posterior end tapering to a narrow tube extending to base of anal spine, bearing 11 to 13 pairs of arborescent appendages.

Colour in alcohol: Body silvery, shot with gold and purple; upper half of first dorsal blackish. Soft dorsal, caudal and anal fins dark externally. Anal fin with darkish basal band.

Distribution: Throughout the larger rivers of India and Burma, Bangladesh and South China.

Size: Grows upto 300 mm in total length.

I thank Dr. M.S. Jairajpuri, Director, Dr. A.K. Ghosh, Joint Director and T.K. Sen, Scientist "SD", Zoological Susrvey of India, Calcutta for encouragement and facilities. I also thank N. C. Ghose, Deputy Director of Fisheries (south Tripura) for collection of the specimen.

January 2, 1992 R. P. BARMAN

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28. *DICHOCROSIS FESTIVALIS* SWINH. (LEPIDOPTERA: PYRALIDAE) — A NEW PEST OF LITCHI *LITCHI CHINENSIS* SONN.

Dichocrosis festivalis Swinh. was recorded for the first time as a new pest of litchi *Litchi chinensis* Sonn. in some litchi orchards of Manglore (Hardwar). Its maximal activity was noticed in the first fortnight of June, during 1988-89 and 1989-90. The infestation was recorded to be 11.36 to 33.33%. The newly hatched larva, which is pinkish brown in colour, makes a small hole near the stalk end of the fruit and enters the larva after going through the pulp, bores into the seed and feeds on the endocarp and the cotyledons at the anterior end of the seed. The damaged portion of the fruit becomes filled with brown coloured frass and excreta of the larva matching with the colour of the endocarp. The affected fruits fall prematurely. Full grown larva having pinkish brown colour measures about 7.5 mm x 1.74 mm. The moths are of medium size, uniformly brownish yellow with numerous black dots on the wings. The insect, though it has caused very serious damage to litchi fruits during the last two years, is of restricted and sporadic occurrence.

We thank Dr. Pratap Singh, Forest Entomologist, Forest Research Institute, Dehra Dun for identifying the insect.

Y. P. SINGH
V. KUMAR

March 18, 1991

29. RECORD OF THE ARACHNID ORDER SCHIZOMIDA FROM ARUNACHAL PRADESH

The Schizomida are one among the scarcely known arachnids that occur in India. The animals belonging to this order are commonly known as micro-whip-scorpions, and are generally found in forest litter, under stones and crevices in rocks. Due to their rarity and small body size they are not usually noticed.

There are as many as 15 species described from India, Sri Lanka and Burma (Bastawade 1988, and Bastawade *et al.* 1988). Among these only four species have been described from India (Bastawade 1988) and including the species *Schizomus sujuensis* Gravely 1925 described from Suju caves, Garo Hills, Meghalaya (earlier Assam) in north-east India.

During a recent faunistic survey of Lohit, Tirap and Changlang districts of Arunachal Pradesh in February-March 1990 by Zoological Survey of India, Arunachal Pradesh Field Station, Itangar I collected two mature Schizomids, one male and one female. These specimens were collected from Miao (450 m above msl) in Tirap district. Unlike specimens found under stones and crevices in western India, these were collected from under a log. They are larger in body size (6.5 mm) and pinkish yellow in colour differing both in size (4.00 to 5.00 mm) and colour (dark olive green) from the Western Ghats forms.

The Schizomids were not known from Arunachal Pradesh before the present collection. This record is an extension of the known distribution.

Correct taxonomic assignment awaits detailed examination of the genitalia and comparison with *Schizomus sujuensis* Gravely.

We thank Prof. (Dr) M.S. Jairajpuri, Director, Zoological Survey of India, Calcutta, Dr. J.R.B. Alfred, Joint Director, ZSI, Calcutta and P.T. Bhutia, ZSI, Arunachal Pradesh Field Station, Itanagar for providing us facilities, constant encouragement and suggesting improvements in manuscript. We also thank Dr. N.C. Nandi, ZSI, Calcutta for his help during the collection of these specimens.

DESHABHUSAN BASTAWADE
TARUN KUMAR PAL

January 30, 1991

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30. REDESCRIPTION OF *ARANEUS FULVUS* DYAL (ARANEAE: ARANEIDAE) FROM COASTAL ANDHRA PRADESH

(With a text-figure)

Tikader (1982) has revised the family Araneidae from India and described with illustrations nine species of the genus *Araneus* Clerck. Unfortunately Dyal's (1935) collection of *Araneus fulvus* Dyal, *A. alboquadratus* Dyal, *A. camilla* (Simon), *A. formosus* Dyal and *A. umbralica* (Clerck) from Lahore (now in Pakistan) were not considered by him in his revisionary work.

Caporiacco (1934-1935) described *Araneus cucurbitinus* Clerck, *A. altitudinum* Cap., *A. obscurissimus* Cap., *A. carbonarius* (L. Koch), *A. angulatus* Clerck, *A. pontii* Cap., and *A. redii* Scopoli from Karakoram, Himalaya. Out of these seven species only *A. cucurbitinus* is included by Tikader (1982) in his fauna and the redescription and illustrations of it are given based on one specimen collected by him from Shillong, Meghalaya; the rest are omitted. These omissions may be due to unavailability of these type-specimens.

While examining the spider collections made by one of us (TSR) from coastal Andhra Pradesh, we came across *Araneus fulvus* Dyal (1935), which is described and illustrated here as Dyal's description and a simple dorsal view diagram based on a single female specimen are found inadequate.

Araneus fulvus Dyal (1935)
(Fig. 1, A - G)

Specimens examined: 2 f, 1 m Tekkali, 3 f Palasa and 1 f Budumur, Dist. Srikakulam; 5 f, 2 m Gajapathinagaram, 2 f Bobbili and 1 f, 1 m Vigianagaram, Dist. Vigianagaram; 1 f Araku, 3 f, 2 m Anakapalli, 2 f, 1 m Bhimili, 4 f, 2 m, Simhachalam, 5 f, 2 m Elamanchili, Dist. Visakhapatnam; 6 f, 3 m Draksharamam, 3 f Ambojepeta, 4 f, 3 m Kesavaram, 1 f Amalpuram and 3 f, 1 m Tuni, Dist. East Godavari; 2 f Doramamidi, 2 f Kovvur, 7 f, 3 m Chinthalapuli, 2 f, 2 m Eluru, Dist. West Godavari; 4 f 1 m Kaikalur, 2 f Machilipatnam and 3 f, 2 m Pamarru, Dist. Krishna; 3 f Chinamatlapeedi, 5 f, 1 m Kanagala, 3 f, 1 m Mangalagiri, 7 f, 2 m Tenali, 1 f Vinukonda and 9 f, 4 m Valiveru, Dist. Guntur; 2 f, 2 m Chirala, 6 f, 2 m Podile, 1 f Tangutur, 2 f Kanigiri and 2 f, 1 m Darsi, Dist. Prakasam; 4 f, 1 m Nellore, 3 f Manubolu, 5 f, 1 m Nayudupeta, 4 f, 2 m Atmakur and 1 f, 1 m Kota, Dist. Nellore. Coll. T.S. Reddy during the years 1985 to 1988.

General: Cephalothorax reddish black, legs reddish brown, abdomen yellowish brown. Total length 19.06 mm. Carapace 6.40 mm long, 4.80 mm wide; abdomen 13.06 mm long, 7.46 mm wide.

Cephalothorax: Longer than wide, reddish black in colour. Cephalic region high and covered with grey hairs. Cephalic region is clearly separated by a distinct cervical groove. Centre of the thoracic region is provided with an indistinct transverse groove. Both rows of eyes recurved. Anterior medians are much larger than the posterior medians, anterior laterals are larger than the eyes of posterior row. The distance between anterior medians is one-third of the distance between anterior median and anterior laterals and the distance between posterior medians is one sixth of the space between posterior medians and posterior laterals. Lateral eyes are contiguous and situated on a tubercle (Fig. 1 a). Ocular quad longer than wide and much wider in front than behind. Sternum cordate and pointed behind, orange in colour, clothed with pubescence and grey hairs. Labium nearly as long as wide, orange with pale outer margin and provided with thin hairs. Maxillae orange, distal end pale and provided with scapulae. Chelicerae moderately strong, dark brown, provided with median boss, inner and outer margins of fang furrow provided with five teeth each. Legs long, strong, reddish brown, clothed with hairs and spines. Tibiae and metatarsi I and II provided with seven pairs of stout ventral spines and III and IV with four pairs of ventral spines. Leg formula 1/2/4/3.

Male: It is similar but smaller than the female. Total length 11.58 mm. Structure of male palp is as in Fig. 1, e-g.

Abdomen: Oblong, rounded at both ends, without any shoulder prominence or tubercles, yellowish brown in colour. Abdomen dorsally provided with a pair of undulating streaks extending

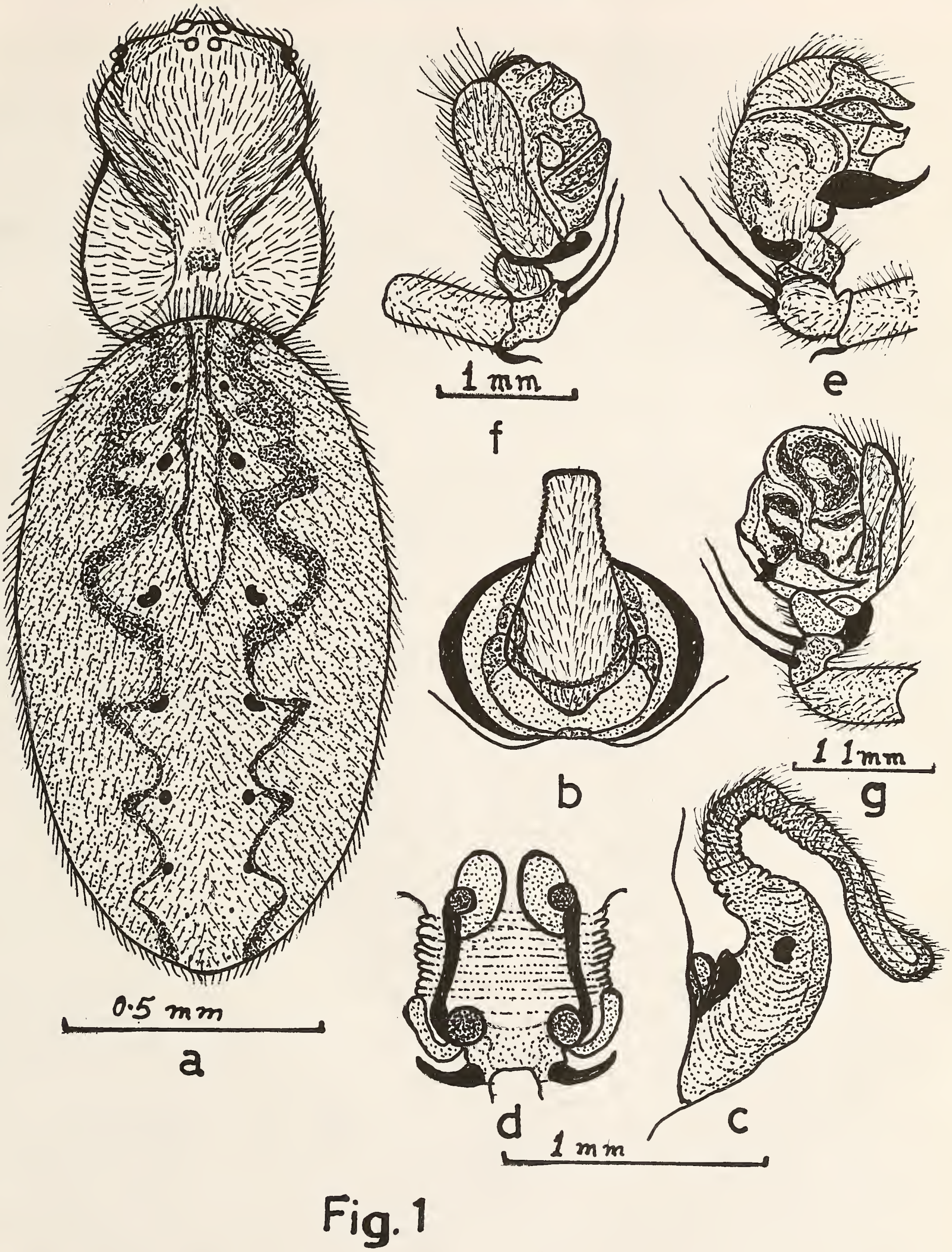

Fig. 1. *Araneus fulvus* Dyal. a. Dorsal view of female (legs omitted), b. Epigyne, c. Epigyne, lateral view, d. Internal genitalia, e. Right male palp, ventral view, f. Right male palp, outer view, g. Right male palp, inner view.

from the anterior to the posterior end; anterior half is provided mid-dorsally with a spear shaped dark lined design. Dorsum provided with six pairs of sigillae arranged mid-longitudinally as in Fig. 1a. Ventral side is brownish black, with a pair of yellowish spots in the centre. Epigyne with a long and wrinkled scape bent at right angles to the body and a pair of basal lamellae as in Fig. 1b, c. Internal genitalia as in Fig. 1 d.

Distribution: All the nine districts of coastal Andhra Pradesh and Gol Bagh, Lahore (now in Pakistan).

We thank Prof. K. B. Tipnis, Principal, Sir P. P. Institute of Science, Bhavnagar for providing laboratory facilities.

T.S. REDDY
B.H. PATEL

March 7, 1991

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31. CLADOCERA OF KEOLADEO NATIONAL PARK, BHARATPUR, IV. NEW RECORDS: *CAMPTOCERCUS* CF. *AUSTRALIS* SARS, 1896 AND *INDIALONA GLOBULOSA* (DADAY, 1898)

(With ten text-figures)

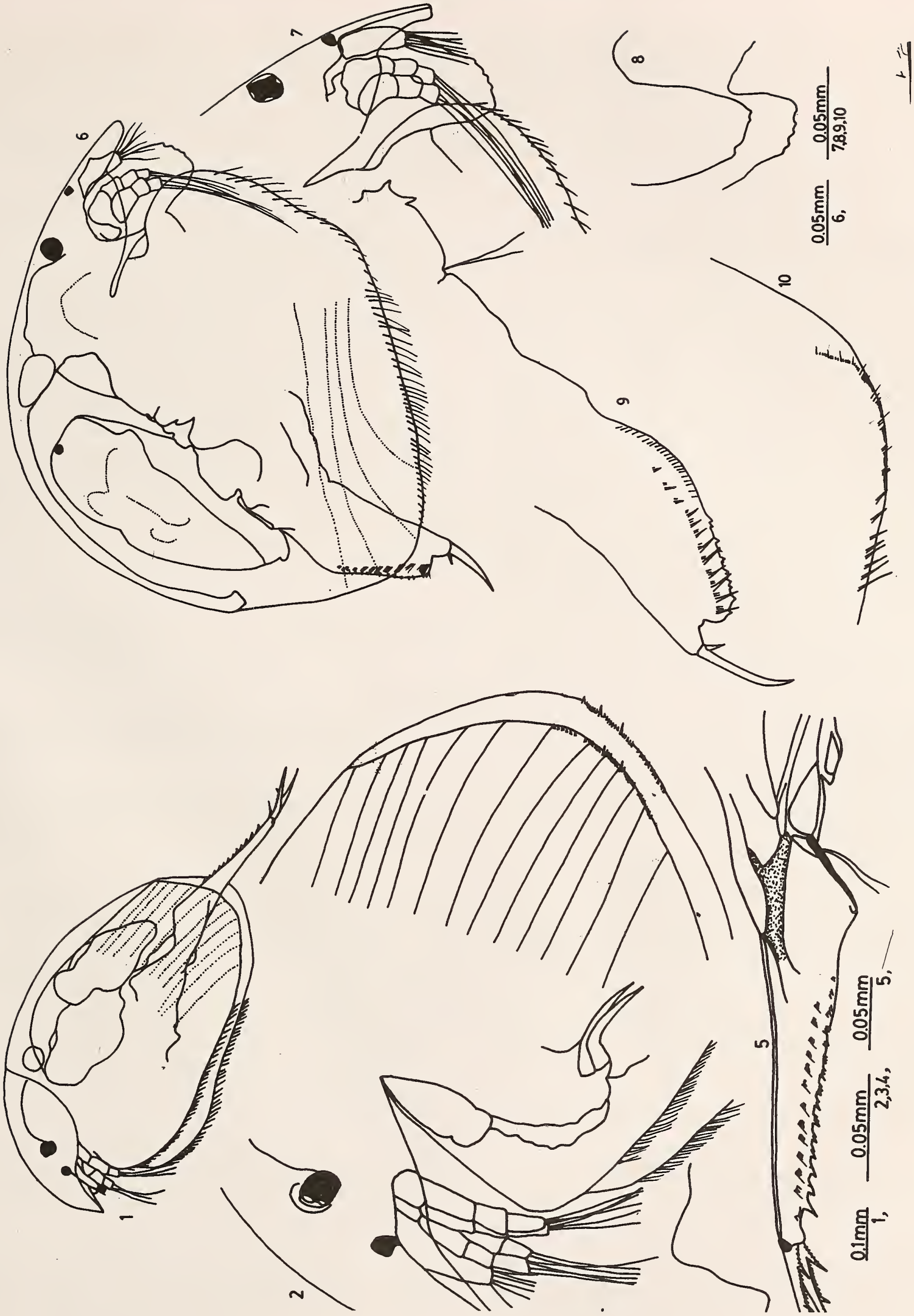
Hitherto, 36 genera containing about 88 species of Cladocera have been recorded from India (Michael and Sharma 1988, Venkataraman 1983, 1992). This may constitute only a part of the total number of species which actually occur in varied habitats in different parts of the subcontinent. The present note deals with two more of the Cladocera species recorded from Keoladeo National Park, Rajasthan. *Camptocercus* cf. *australis* Sars, 1896 is new to the Indian subcontinent while *Indialona globulosa* (Daday, 1898) is recorded for the first time in Rajasthan.

Family: CHYDORIDAE Stebbing, 1902
Subfamily: ALONINAE Frey, 1967
Genus: *Camptocercus* Baird, 1843
Camptocercus cf. australis Sars, 1896 (Figs. 1-5)

Morphological features: Female; size 0.62-0.73 mm. Body oval; maximum height slightly before middle of the body (Fig. 1). Valve with longitudinal line. Posteroventral corner of valves rounded; posterior margin slightly convex with a series of setae. Head keel present, dorsal margin of head and dorsal side of valve forming a smooth curve (Fig. 2). Ocellus smaller than eye. Posteroventral corner rounded with three small denticles, attached submarginally between the series of fine setules and slightly projecting beyond the margin of the valves (Fig. 4). Rostrum pointed and directed anteriorly. Antennules not reaching the apex of rostrum. Setae on antenna are 0-0-3/0-1-3. Plate of labrum with rounded apex (Fig. 3). Head shield with three pores. Post-abdomen long and narrow, with 15-18 anal denticles, lateral setae being small in a group (Fig. 5). Claw long, slightly curved dorsally and pointed dorsally. Basal spine about one fourth the length of claw, pointed on the proximal surface. Intestine forms loops with caecum.

Distribution: Very rare. Collected in Ghana canal of Keoladeo National Park and Ajan Bund reservoir of Bharatpur. Elsewhere — Australia (Henry 1922), China (Sieh-chih and Nan-shan 1979) and Malaysia (Idris 1983).

This is the first record of the species in India. However, Gurney (1907) reported this species from Chakradharpur without any illustration or details of characters to ascertain its validity. The present material differs slightly from *C. australis* by the presence of submarginal denticles on the posteroventral corner of the valves. Other species of



Figs. 1-5. *Camptocercus* cf. *australis* female. 1. Lateral view, 2. Detail of head, 3. Labrum, 4. Posteroventral corner, 5. Postabdomen. Figs. 6-10. *Indialona globulosa* female. 6. Lateral view, 7. Detail of head, 8. Labrum, 9. Postabdomen, 10. Posteroventral corner.

this genus have large marginal denticles which differentiate this species from the rest. However, recent studies on the species from Malaysian rice fields (Idris 1983) and also the present study clearly show that this species also has marginal denticles, which were not reported earlier.

Genus **Indialona** Petkovski, 1966
Indialona globulosa (Daday, 1898) (Figs. 6-10)

Morphological features: Female size 0.35-0.42 mm. Body oval, highly arched dorsally, minimum height before middle (Fig. 6). Posteroventral corner of valves distinct without denticles (Fig. 10). Valves with distinct longitudinal striations. Ventral margin convex with setae turned inward. Ocellus smaller than eye, situated nearer to the eye than to apex of rostrum. Rostrum blunt, antennules reaching about three fourths the length of rostrum (Fig. 7). Plate of labrum convex anteriorly and slightly serrated on antero- ventral margin (Fig. 8) Post-abdomen broadest near anus, with distinct preanal corner. Anal groove concave, post-anal margin slightly tapering distally with rounded dorsal-distal corner. Dorsal margin with 11-13 short denticles. About 13 groups of long and distinct lateral spinules present laterally, the distal most ones being the largest and slightly projecting beyond the dorsal margin (Fig. 9). Claw long and setulated on the concave surface, with a basal spine.

Distribution: Not common. Collected in very small numbers in the marshy habitats of Keoladeo National Park. Elsewhere — Philippines (Mamaril and Fernando 1978) Sri Lanka (Rajapaksa and Fernando 1983) and Malaysia (Idris 1983).

This is the first record of the species in Rajasthan. It was reported earlier from West Bengal (Sharma 1978). The present material agrees well with the description of the species made by Smirnov (1974), Idris (1983) and Michael and Sharma (1988).

I gratefully acknowledge Prof. T.M. Haridasan, School of Energy Sciences, Dr. G.C. Rao, Z.S.I. and Mr. J.C. Daniel, B.N.H.S. for their encouragement.

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K. VENKATARAMAN

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32. RECORD OF THE CONE SHELL *CONUS CUMINGII* (REEVE, 1848) FROM BOMBAY SEAS

Literature on the shells of India is scant and very old. Many of the species mentioned have become rare due to environmental changes and pollution. Crichton (1941), Gravely (1942) and Hornell (1949) described the molluscan fauna of Madras and Indian coast. Literature on shells of Bombay by Subrahmanyam *et al.* (1952) state that there are in all 187 species of Gastropods. But many of these have become very rare. For example, *Lambis lambis* (Linn.) and *Xancus pyrum* (Linn.) have

disappeared, while *Cyprea arabica* (Schilder) has become very rare on Bombay coast. In some of these publications the occurrence of *C. cumingii* has been mentioned.

I came across an unusual cone species which I could not identify, on 21 May 1990 on a south Bombay beach. Subsequently, I made several visits to the same place to make a detailed study of this cone shell. In 1990, I could see seven live specimens of this species, of which two are in my personal collection. This species was later identified as *Conus cumingii* (Reeve, 1848) with the help of Dr. M.G. Harasewych, Divn. of Mollusks, Smithsonian Institution, U.S.A.

The shell is moderately large (average 5.2 cm) with tall spires; outer lip thickened. Chestnut brown in ground colour with a prominent white spotted zone midway on the body whorl. Upper margin of body whorl bears alternately arranged white and brown spots. Brown spiral lines are present on the entire surface, but darker near the upper ridge and at the mid-zone of body whorl.

Distribution: According to Dr. Harasewych, this species has a distribution from the Bay of Bengal to the western rim of Western Pacific, though Van Nostrand (1967) gives its locality as Philippines. It is possible that this form may be a subspecies, but this requires a detailed study.

I thank Dr. M. G Harasewych, Associate Curator, Division of Mollusks, Smithsonian Institution, U.S.A. for help in identifying the shell.

August 9, 1991 DEEPAK APTE

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33. CORRECTIONS AND ADDITIONS TO THE FLORA OF GURDASPUR DISTRICT, PUNJAB

In an earlier communication, Bir and Singh (1989) had reported new records for Punjab State. Sixty nine species of flowering plants collected from Gurdaspur district were added to the list of plants from Punjab. Susequently, during compilation of the flora of Gurdaspur district and Punjab state, re-examination of the materials revealed some startling inaccuracies. Unfortunately, this has been the result of mixing up of specimens and field numbers and wrong identifications. Hence the present communication wherein we report corrections to 'Additions' for Punjab state and make a few other nomenclatural corrections. Specific indentifications and nomenclature of all the 69 species were subsequently checked by comparing with authentic vouchers at BSD.

Correct identifications of 29 species as erroneously reported earlier are given below. For enumeration of the species, original serial numbers are given for quick reference. PUN accession numbers are mentioned for each so as to pin-point the specimens. Other details for locality, collector, etc. remain the same. Correct family reference is made wherever necessary.

2. **Capsella bursa-pastoris** (Linn.) Medik., PUN 35771, 35772.

Lepidium perfoliatum sensu Bir & Singh (1989): non Linn. 1753.

5. **Geranium mascatense** Boiss. var. **himalaicum** Babu (= *G. ocellatum* Camb.) PUN 33348, 33349.

Geranium lucidum sensu Bir & Singh (1989): non Linn. 1753.

*7. **Ranunculus laetus** Wall. ex D. Don, PUN 33630, 33631, Fam: Ranunculaceae.

Geranium wallichianum sensu Bir & Singh (1989): non Don 1825.

TABLE 1

Species number as in Bir and Singh (1989)	Correct name or citation	Name published in Bir and Singh (1989)
1.	*Clematis gouriana* Roxb. ex DC.	*Clematis gouriana* Roxb.
3.	*Polygala abyssinica* R.Br. ex Fresen.	*Polygala abyssinica* R. Br.
4.	*Hypericum oblongifolium* Choisy	*Hypericum cernuum* Roxb.
8.	*Argyrolobium flaccidum* (Royle) Jaub. & Spach.	*Argyrolobium flaccidum* Jaub. & Spach.
9.	*Atylosia volubilis* (Blanco) Gamble	*Atylosia crassa* Prain
31.	*Taraxacum officinale* Wiggers	*Taraxacum officinale* Webber
33.	*Primula umbellata* (Lour.) Bentv.	*Androsace umbellata* (Lour.) Merr.
37.	*Centaurium centaurioides* (Roxb.) Rao & Hemadri	*Centaurium centaurioides* (Roxb.) comb. nov.
46.	*Rostellularia diffusa* (Willd.) Nees	*Rostellularia diffusa* Nees
47.	*R. mollissima* (Nees) Nees	*R. mollissima* Nees
52.	*Polygonum nepalense* Meissn.	*Polygonum alatum* Buch.-Ham.
54.	*Polygonum capitatum* Buch.-Ham. ex D. Don	*Polygonum capitatum* Buch.- Ham.
58.	*Securinega virosa* (Roxb. ex Willd.) Baill.	*Flueggea virosa* Roxb. ex Willd.

10. **Crotalaria prostrata** Rottl. ex Willd., PUN 33926
Crotalaria pusilla sensu Bir & Singh (1989): Non Heyne 1821.
11. **Desmodium elegans** DC., PUN 34170, 34171.
Desmodium podocarpum sensu Bir & Singh (1989): non DC. 1825.
14. **Rubus niveus** Thunb., PUN 34180, 34181.
Rubus biflorus sensu Bir & Singh (1989): non Buch.-Ham. 1819.
19. **Premna mucronata** Roxb., PUN 33907, 33909, Fam: Verbenaceae.
Viburnum coriaceum sensu Bir & Singh (1989) : non Bl. 1826-1827.
20. **Ehretia aspera** Roxb., PUN 34151, Fam: Ehretiaceae.
Viburnum erubescens sensu Bir & Singh (1989): non wall. 1820.
21. **Oldenlandia corymbosa** Linn., PUN 31189, 31190.
Galium asperifolium sensu Bir & Singh (1989) : non wall. 1820.
*22. **Rubia cordifolia** Linn., PUN 34182.
Galium hirtiflorum sensu Bir & Singh (1989): Non DC. 1838.
23. **Xylosma longifolium** Clos., PUN 35172, fam: Flacourtiaceae.
Plectronia neilgheriensis Bedd. var. *chartacea* sensu Bir & Singh (1989): non Gamble 1918.
25. **Gnaphalium luteo-album** Linn., PUN 33607, 33608.
Anaphalis busua sensu Bir & Singh (1989): non DC. 1838.
*28. **Erigeron karvinskianus** DC., PUN 34167.
Erigeron multicaulis sensu Bir & Singh (1989) : non DC. 1838.
32. **Lindernia crustacea** (Linn.) F.V. Muell., PUN 31191, 31192, Fam: Scrophulariaceae.
Lobelia heyniana sensu Bir & Singh (1989): non Roem & Schult. 1819.
34. **Grewia disperma** Rottl. ex Spreng., PUN 31445, 31446, Fam: Tiliaceae.
Symplocos sumuntia sensu Bir & Singh (1989): non Don 1825.
35. **Reinwardtia indica** Dum., PUN 33419, 33450, Fam: Linaceae.
Jasminum humile sensu Bir & Singh (1939): non Linn. 1753.
38. **Gentiana aprica** Decne, PUN 33615.
Gentiana argentea sensu Bir & Singh (1989) : non DC. 1838.
*39. **Swertia angustifolia** Buch.-Ham. ex D. Don, PUN 34179.
Swertia purpurascens sensu Bir & Singh (1989): on

wall. 1831

42. **Limnophila indica** (Linn.) Druce, PUN 34123.
Limnophila connata sensu Bir & Singh (1989) : non Don 1825.

44. **Limnophila indica** (Linn.) Druce, PUN 34120.
Sutera dissecta sensu Bir & Singh (1989): non Walp. 1842.

45. **Maytenus royleanus** (Wall. ex Lawson) Cuf. (=*Gymnosporia royleana* wall. ex Lawson), PUN 33611, 33612, Fam: Celastraceae.
Barleria buxifolia sensu Bir & Singh (1989): non Linn. 1753.

49. **Nepeta hindostana** (Roth) Haines, PUN 33914.
Nepeta graciliflora sensu Bir & Singh (1989) : non Benth. 1830.

50. **Ocimus canum** Sim., PUN 33922, 33923.
Plectranthus japonicus sensu Bir & Singh (1989): non Koidz. 1829.

55. **Polygonum barbatum** Linn. subsp. **gracile** Danser, PUN 31203, 31204.
Polygonum donii sensu Bir & Singh (1989): non Meissn. 1826.

59. **Trema politoria** Planch., PUN 31497, 31498.
Trema orientalis sensu Bir & Singh (1989): non Roxb. 1832.

64. **Cyperus paniceus** (Rottb.) Boeck. var. **roxburghianus** (Cl.) Kuek., PUN 35498, 35499.
Cyperus cyperoides sensu Bir & Singh (1989): non Kuntze 1898.

65. **Chrysopogon serrulatus** Trin., PUN 34066, 34067.
Chrysopogon fulvus sensu Bir & Singh (1989): non Chiov. 1919.

66. **Eragrostis atrovirens** (Desf.) Trin. ex Steud., PUN 34128, 34129.
Eragrostis curvala sensu Bir & Singh (1989): non Nees 1854.

68. **Carex filicina** Nees, PUN 34068, 34069, Fam.: Cyperaceae.
Themeda villosa sensu Bir & Singh (1989): non Camus 1922.

Four species marked thus (*) still remain as 'New Records' for Punjab, whereas in the light of studies made by Sharma (1982a, b, 1985), the names of the other 25 species enumerated above need to be deleted from the list of additions given by Bir and Singh (1989).

Correct and currently accepted names and/or author's citations for some species (misquoted earlier) are given in Table 1.

Crotalaria and *Desmodium* which were inadvertently included under Rosaceae should find place under Fabaceae.

The following species are additional 'New Records' for Punjab State. These are not included by Sharma (1990).

1. **Lepidium virginicum** Linn. A frequently occurring herb in the hilly-tract. *Fl. & fr.* March-August. *Charanpreet* 16568, Katori, 15 May, 1987 (PUN 35178, 35179). Family : Brassicaceae.
2. **Rhamnus purpurea** Edgew. A shrub growing near rocks in hilly tracts *Fl. & Fr.* September -December. *Charanpreet* 13677, Bhattwan, 10 September, 1986 (PUN 35476, 35477). Family: Rhamnaceae.
3. **Zanthoxylum armatum** DC. A small, strongly prickled tree. *Fl. & Fr.:* March-September. *Charanpreet* 13199, Katori, 10 March, 1986 (PUN 33634, 33635). Family: Rutaceae.
4. **Alternanthera philoxeroides** (Mart.) Griseb. A common herb in marshy places along perennial streams. *Fl. & Fr.* August-November. *Charanpreet* 12247, Pathankot, 20 October, 1986 (PUN 35478, 35479). Family Amaranthaceae.
5. **Costus speciosus** Smith. Found near perennial streams in the ravines of hill-tracts. *Fl. & Fr.* August-October. *Charanpreet* 13651, Dunera, 14 September, 1986 (PUN 35173, 35174). Family : Zingiberaceae.
6. **Arisaema jacquemontii** Blume. Found on slopes in shaded places. *Fl.:* June-November. *Charanpreet* 13657, Dunera, 14 September, 1986 (PUN 35180). Family : Araceae.
7. **Eleocharis geniculata** (Linn.) Roem. & Shult. A common plant in marshy and water logged areas. *Fl. & Fr.:* July-November. *Charanpreet* 9738, Dinanagar, 3 October, 1983 (PUN 35472-35475). Family: Cyperaceae.

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November 25, 1991

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34. ADDITIONS TO THE FLORA OF BIHAR

The present communication highlights the occurrence and distribution of some rare and interesting angiosperms from eastern parts of Bihar state. During a detailed floristic exploration (1986-91) of eastern Bihar (23° 40' – 26° 35' N, 85° 30' – 88° 32' E), we could collect *Blumea obliqua* (L.) Druce (Asteraceae); *Calamus latifolius* Roxb. (Arecaceae); *Canavalia cathartica* Thouars. (Fabaceae); *Dendrobium peguanum* Lindl. (Orchidaceae); *Elatostema cuneatum* Wight (Urlicaceae); *Eragrostis aspera* (Jacq.) Nees (Poaceae); *Exacum carinatum* Roxb. (Gentianaceae); *Fimbristylis alboviridis* Clarke (Cyperaceae); *Peemna coriacea* Clark (Verbenaceae); *Spilanthes iabadicensis* A. H. Moore (Asteraceae) and *Stephania glandulifera* Miers (Menispermaceae). These taxa have not been recorded earlier from Bihar (Haines 1921-25, Mooney 1950, Bressers 1951, Panigrahi 1966, Srivastava 1959, Varma 1981, Singh 1986).

Hence the present collection and the distributional notes of these taxa would be of interest in highlighting their extended range of distribution in new areas not recorded earlier and it will also help in their conservation, as some of them are often used by tribal people. Brief descriptions, distribution and ecology of the species are given below. All the cited specimens have been deposited in the Bhagalpur University Herbarium, Bhagalpur. The identifications of the specimens have been confirmed at the Central National Herbarium (CAL).

Blumea obliqua (L.) Druce in Rep. Bpt. Exch. Club. Brit. Isles 4:609.1916(1917); Randeria, Blumea 10(1) : 286. 1960. *Erigeron obliqum* L. Mant. 2:573.1771. *Blumea amplectans* DC. in Wight Contrib. Bot. Ind. 13.1834; Hook. f. Fl. Brit. Ind. 2: 260. 1881; Haines, Bot. Bih. & Oris. 2: 491.1961 (Repr. ed.).

Annual herb, up to 50 cm high, much branched; stems puberulous, leaves 2-9 cm long, upper amplexicaul, scabrous to velutinous; capitula solitary, 6-8 mm in diameter, terminal or in the axial of upper leaves; pedunculate, peduncles up to 5 cm long; achens brown, pubescent, not ribbed; pappus white.

Flowering and fruiting: March-July.

Distribution: INDIA: Bengal, Orissa; Ceylon.

Ecology: Dry as well as wet places in waste lands, river banks; rare.

Specimens examined: Sakrigali (Sahibganj Dist.), Sriwastawa 4625; Jamalpur (Munger Dist.), Jha 7125.

Calamus latifolius Roxb., Fl. Ind. 3: 775. 1832; Hook. f. Fl. Brit. Ind. 6: 455. 1892; Haines, Bot. Bih. & Oris. 3:928. 1961 (Repr. ed.): Prain, Bengal Plants 2:827. 1963 (Repr. ed.).

A stout erect or scandent armed shrub; leaves rachis produced into a long flagellum, armed with recurved prickles; leaflets elliptic or elliptic-lanceolate; male spikes 6-15 cm long, flowers green, 4-7 mm long; female spikes 8-12 cm long, flowers greenish yellow, minute. Fruits 0.3-0.6 mm long, sub-globose, pale yellow.

Flowering and fruiting: December-April.

Distribution: INDIA: Assam, Bengal, Orissa and Sikkim Himalaya; Burma.

Ecology: In waste land, along railway embankment; rare.

Specimens examined: Mangalhat (Sahibganj dist.), Varma 2228; Shivnarayanpur (Bhagalpur dist.), Jha 6326.

Canavalia cathartica Thouars. in J. Bot. Desv. 1:81. 1813; Saucer, Brittonia 16: 159.1964; Guha Bakshi, Fl. Murshidabad 101. 1984. *C. ensiformis* (L.) DC. var. *turgida* (Grah. ex Miq.) Baker in Hook. f. Fl. Brit. Ind. 2:196.1876.

Local name: Thon (Santhali).

Perennial climber; leaves 3-foliate; flowers

purple, upto 3 cm long; pods 15-20 x 3.5-4.2 cm. straw coloured, turgid; seeds 5-11, 2-2.8 mm long, pale cream.

Flowering, fruiting: September-April.

Distribution: INDIA: Maharashtra, Karnataka, Tamil Nadu, Orissa, West Bengal, Andaman and Nicobar islands; Sri Lanka, Madagascar.

Ecology: In mixed forests: rare.

Specimens examined: Gilamari (Sahibganj dist.), Jha 6351.

Uses: The seeds and young fruits are eaten.

Dendrobium peguanum Lindl. in J. Linn. Soc. Bot. 3.19. 1859; Hunt, Kew Bull. 24: 90.1970. *D. pygmaeum* Lindl. Gen. Sp. Orch. Pl. 85.1830 (non Sm. 1918); Hook. f. Fl. Brit. Ind. 5:717.1890; Haines, Bot. Bih. & Oris. 3:1224.1961 (Repr. ed.).

A small densely tufted epiphyte upto 4 cm long, with greenish ovoid pseudobulbs; leaves 2-3, linear, caducous; racemes upto 3 cm long; flowers white or pale purp:le; sepal s linear, 6-8 mm long, lateral decurved; petals oblanceolate, lip obovate, mid-lobe triangular crisped, disc with crenate fleshy ridges.

Flower and fruits: December-March.

Distribution: INDIA: Bengal, Orissa.

Ecology: In mixed forests growing on *Syzygium cumini* (L.) Skeels; rare.

Specimens examined: Silingi (Dumka Dist.), Singh 5447; Jha 6285.

Elatostema cuneatum Wight, Ic. t. 2091. f. 3.1853; Hook. f. Fl. Brit. Ind. 5:564.1886; Gamble, Fl. Madras 1377 (963).1928; Saldanha and Nicolson, Fl. Hassan Dist. 88.1976; Babu, Fl. Dehradun 467.1977.

Monoecious, slender, erect, annual herbs, upto 15 cm tall; leaves simple, alternate, sessile, falcate-cuneate or obovate, aggregated towards the tops; upper leaves upto 2x1 cm, oblique, crenate-serrate above the middle, entire below, sparsely citose and marked with numerous cystolith above; lower leaves smaller than the upper; flowers minute, regular, sub-sessile, arranged on axillary involucrate receptacle; bracteoles many, mixed with flowers, linear-oblong, ciliate at the tip; male flowers white, restricted to the top most or the next lower receptacle, intermingled with female flowers; perianth lobes 4, ovate, obtuse, glabrous; stamens 4; female flowers numerous; perianth lobes 3-4; style penicillate; achens reddish brown, ellipsoid, ribbed, glabrous, 0.5 mm long.

Flowering, fruiting: September-April.

Distribution: INDIA: Eastern and Western Ghats, Sikkim Himalaya, Dehra Dun, Meghalaya.

Ecology: Along stream banks in ravines, on moist rocks and at the base of trees; rare.

Specimens examined: Motijharna, 2.5 km south-west of Maharajpur railway station (Sahibganj dist.), Jha 6327.

Eragrostis aspera (Jacq.) Nees, Fl. Afr. Austr. 408.1841; Hook. f. Fl. Brit. Ind. 7: 314. 1896; Bor Gr. Burma, Ceylon, Ind. & Pak. 501. 1960, Patunker, Gr. Marath. 245. 1980. *Poa aspera* Jacq. Hort. Vindob. 3: 32. 1776.

Annual, up to 1 m high; culms erect, much branched, glabrous; leaf-blades 10-30 x 0.4-0.8 cm, linear-lanceolate, glabrous, acuminate; ligules a ciliate rim; panicles 50 x 20 cm, thyrsiform, ovate-oblong; spikelets up to 20- flowered, 4-10 mm long, white; glumes 0.6-1.2 mm long, narrowly oblong, 1-nerved; lemmas 1.2-1.7 mm long, elliptic-oblong, 3-nerved; palea 2-keeled, scabrid; stamens 3; anthers 0.1-0.3 mm long, pink; caryopsis 0.3-0.5 mm long, subglobose.

Flowering, fruiting: August - December.

Distribution: INDIA: Rajasthan, Marathwada, south India; Africa, Mascarend islands, Australia.

Ecology: In cultivated land; rare.

Specimens examined: Mirzachowki (Sahibganj dist.), Jha 6631.

Exacum carinatum Roxb., Fl. Ind. 1:415. 1820; Ramamoorthy in Fl. Hassan Dist. 425. 1976. *E. petiolare* Griseb in DC. Prodr. 9:46.1845; Clarke in Fl. Brit. Ind. 4:98. 1883; Haines, Bot. Bih. & Oris. 2: 595. 1961 (Repr. ed).

An annual herb, up to 15 cm high; leaves elliptic- ovate, 3-7.5 cm long, base broad, glabrous, up to 7-nerved, acuminate, petiole short; flowers white or bluish, axillary and in terminal cymes, tetramerous; calyx and corolla 4-lobed; fruits up to 6 mm long, winged; seeds small, brown, angled, subquadrate.

Flowering, fruiting: September - December.

Distribution: INDIA: Karnataka, central and south-west India.

Ecology: On moist rocks under shade; rare.

Specimens examined: Karanpurato (Sahibganj dist.), Jha & Singh 6546.

Fimbristylis alboviridis Clarke in Hook. f. Fl. Brit. Ind. 6:638. 1893; Kern in Fl. Malesiana, 580. 1974; Rao & Varma, Cyp. N. E. Ind. 35. 1982.

A tufted annual, up to 10 cm high; culms slender, compressed, glabrous; leaves slightly falcate, flat, obtuse to acute, ligulate, spikes loose, with few to several spikelets, whitish green; spikelets solitary, 4-7 mm long, ovoid to oblong-ovoid, many-flowered, acute; glumes broadly ovate, 1.5-2 mm long, subchartaceous, glabrous, with 3-nerved keel; stamens 1; style slightly dilated at the base, upper ciliate; stigmas 2; achens shortly stipitate, obovoid, 1 mm long, verruculose, trabeculate, with 10-16 vertical rows on each surface.

Flowering and fruiting: August - December.

Distribution: INDIA: Assam, Meghalaya, Madhya Pradesh; Bangladesh, Malaysia.

Ecology: In open wasteland; rare.

Specimens examined: Bandanwar (Godda dist.), Varma & Jha 7302.

Premna coriacea Clarke in Hook. f. Fl. Brit. Ind. 4: 573. 1881; Haines, Bot. Bih. & Oris. 2: 749. 1961 (Repr. ed.).

A woody climber. Leaves 5-10 cm long, broadly oblong or ovate, caudate, glabrous, acuminate, base rounded, smooth; panicles up to 3 cm long; flowers 2-6 mm long, white, scented; bracts filiform, caducous; calyx cupular truncate; corrolla tube 1-2.5 mm long, throat-bearded; drupe narrowly obovoid; seed 1.

Flowering and fruiting: March - July.

Distribution: INDIA: Western Deccan Peninsula, Orissa.

Ecology: Along stream banks; rare.

Specimens examined: Karamtola (Sahibganj dist.), Jha 7141.

Uses: The leaves are used as fodder.

Spilanthes iabadicensis A. H. Moore, Proc. Amer. Acad. Arts. 42: 542. 1907; Koster & Philipson, Blumea 6: 354. 1950; Grierson in Dassanayake & Fosberg, Rev. Handb. Fl. Ceylon 1: 221. 1980.

Herbs, up to 40 cm high; stems weak, decumbent, rooting at the lower nodes, sparsely pubescent when young; leaves 1-5 x 0.5-2.5 cm, narrowly ovate or elliptic, acuminate, margins undulate or serrate-dentate; capitula conical-ovoid, 3-5 mm in diameter, radiate, yellow; peduncles 2-5 cm long; ray flowers 1.5-2 mm long, ligulate, 3-lobed, yellow; disc flowers 1-1.25 mm long, 3-5-lobed; achens 1-1.75 mm long, black with pale margins, sparsely and weakly ciliate along both margins or sometimes only one; pappus weak fragile, 0.25 mm long.

Flowering and fruiting: Throughout the year.

Distribution: INDIA: Madhya Pradesh; Sri Lanka, Sumatra, Java, New Guinea.

Ecology: Moist grounds, rice-fields and ditches; common.

Specimens examined: Chattarpur (Saharsa dist.), Sinha 501; Babupur (Sahibganj dist.), Jha 7115; Jamalpur (Munger dist.), Jha 6598.

Stephania glandulifera Miers in Contr. Bot. 3: 220. 1871; Kanjilal, Fl. Assam. 1: 52. 1934; Whitemore, Enum. Fl. Pl. Nepal 2: 28. 1979. *S. rotunda* auct. non Lour. ; Hook. f. & Thoms., Fl. Brit. Ind. 1: 103. 1872 p. p.

Local name: Patal Kumhra (Sauria Paharia).

A dioecious climber with globose tuberous roots, 10-15 cm in diameter, deep-yellow inside; leaves orbicular, 7-15 cm in diameter, peltate, margins entire, membranous, glabrous, basal nerves 9; petiole 7-18 cm long ; female flowers in cymose umbels, yellow-orange, peduncles axillary; sepals 6, obovate, narrow; petals shorter than the sepals, obovate.

Flowering and fruiting: July - October.

Distribution: INDIA: Himalaya, Assam, Arunachal Pradesh.

Ecology: In mixed forests; rare.

Specimens examined: Angwali (Dumka dist.), Varma & Jha 7163.

The medicinal uses ascribed to *Stephania glandulifera* Miers are perhaps due to its superficial resemblance with the tuber of *Pueraria tuberosa* DC. of Fabaceae having a similar local name. The latter is commonly used for renal and bowel complaints (Haines l.c.). However, critical examination, both in the field and in the garden helped us in the correct identification of the former, which has not been recorded earlier from Bihar.

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35. ADDITIONAL HOST SPECIES FOR *LORANTHUS* AND THEIR LOCALITIES IN THANJAVUR DISTRICT, TAMIL NADU

The phorophytes or host trees in dry evergreen forest provide ideal habitats for epiphytic orchids and semiparasitic plants. *Sapindus emarginatus, Diospyros ferrea* and *Borassus flabellifer* are common phorophytes. *Cymbidium aloifolium, Vanda spathulata* and *V. tessellata* are the epiphytic orchids in Thanjavur district.

Dendrophthoe falcata, Viscum orientale and *V. capitellatum* are the destructive semi-parasites found on a number of plants. According to Singh (1963), 319 species of plants are attacked by these parasites in India. Balasubramanian *et al.* (1986) reported 29 host species in Point Calimere, Thanjavur dt. We found an additional 22 new host species for this parasite in Thanjavur district as a result of a 3 year study. The complete list of host plants from this district is presented in Table 1.

The host species that are new records for India are marked with an asterisk and plus mark denotes double parasitism. One species being parasitic on

TABLE 1

LIST OF HOST SPECIES FOR *Loranthus* AND THEIR LOCALITIES

	Acacia leucophloea Willd. (Manakkal)	*	*Ehretia pubescens* Benth. (Melathottum)
	Aegle marmelos (L.) Corr. (Vallum)	* +	*Excoecaria agallocha* L. (Pazhayar)
	Alangium salviifolium (L.f.) Wang. (Peravurani)		*Ficus benghalensis* L. (Kodiakkarai RF)
*	*Albizzia amara* (Roxb.) Boivin (Peravurani)	*	*F. racemosa* L. (Mailaduthurai)
	A. lebbeck (L.) Benth. (Kodiakkarai)		*F. religiosa* L. (Kodiakkarai RF)
*	*Anacardium occidentale* L. (Avanam)		*Gmelina asiatica* L. (Pazhayar)
	Artocarpus heterophyllus Lam. (Mailaduthurai)		*Grewia rhamnifolia* Heyne ex Roth. (Poompuhar)
*	*Azadirachta indica* Juss. (Ammapet)	*	*Hugonia mystax* L. (Kodiakkarai RF)
*	*Bombax ceiba* L. (Melathotum)	+	*Ixora pavetta* Andr. (Kodiakkarai RF)
	Cadaba fruiticosa (L.) Druce (Peravurani)	*	*Jatropha curcas* L. (Kallimedu)
*	*Calophyllum inophyllum* L. (Velankanni)	+	*Lannea coromandelica* (Houtt.) Merr. (Kodiakkarai RF)
	Canthium parviflorum Lam. (Kodiakkarai RF)	+	*Lepisanthes tetraphylla* (Vahl) Radlk. (Periakuthakai)
*	*Carmona retusa* (Vahl) Masam. (Melathottum)	+	*Manilkara hexandra* (Roxb.) Dubard (Kodiakkarai RF)
	Cassia fistula L. (Kodiakkarai RF)	+	*Mangifera indica* L. (Ammapet)
	C. roxburghii DC. (Kodiakkarai RF)		*Maytenus emarginata* (Willd.) Ding Hou (Kodiakkarai RF)
	C. siamea Lam. (Melathottum)		*Memecylon edule* Roxb. (Kodiakkarai RF)
	Casuarina litorea L. (Pazhayar)	* +	*Mimusops elengi* L. (Ammapet)
	Catunaregam spinosa (Thunb.) (Tirven.) (KRF)	*	*Morinda pubescens* J.E. Smith (Melathottum)
	Carissa spinarum L. (Kodiakkarai RF)	+	*Pithecellobium dulce* (Roxb.) Benth. (Kodiakkarai RF)
	Cissus vitiginea L. (Kodiakkarai RF)	+	*Pongamia pinnata* (L.) Pierre (Kodiakkarai RF)
+	*Commiphora caudata* Engl. (Kodiakkarai RF)		*Prosopis chilensis* (Molina) Stuntz. (Manakkal)
	Cordia obliqua Willd. (Kodiakkarai RF)	*	*Rhizophora apiculata* Blume (Pazhayar)
	Crateva adamsonii DC. (Rajamadam)	* +	*Salvadora persica* L. (Kodiakkarai RF)
*	*Dalbergia sissoo* Roxb. (Aduthurai)		*Salix tetrasperma* Roxb. (Sirkazhi)
	Dichrostachys cinerea W. & A. (Kodiakkarai RF)		*Scutia myrtina* (Burm. f.) Kurz. (Kodiakkarai RF)

another parasite of the same or allied genera (Saxena 1971) were also recorded. *Viscum capitellatum*, parasitic on *D. falcata* was in turn parasitic on other species of plants.

The economically valuable tree species such as *Albizzia lebbeck, Anacardium occidentale, Artocarpus heterophyllus, Bombax ceiba, Cassia siamea, Casuarina litorea, Dalbergia sissoo, Ficus religiosa, Manilkara hexandra, Mangifera indica, Pithecellobium dulce, Salvadora persica, Syzygium cumini, Tectona grandis, Terminalia catappa, Thespesia populnea* are severely affected by the parasite *D. falcata*, with many trees in and around this district being heavily infected.

The parasite is a prolific producer of fruits, avidly devoured by some species of frugivorous birds that disperse the seeds of *D. falcata* .

No effective control measures are presently available. Diesel or powerine oil (30-50%) is sprayed on *D. falcata* to reduce its growth (Singh 1963). Its spread in Thanjavur forests will be disastrous considering the wildlife wealth.

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May 29, 1991 A. MAHADEVAN

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36. *VETIVERIA LAWSONI* (HOOK. F.) BLATTER & MCCANN AND *POTAMOGETON CRISPUS* L. — ADDITIONS TO THE FLORA OF ANDHRA PRADESH

During the course of intensive plant exploration in Nizamabad district of Andhra Pradesh, we collected two uncommon taxa. These taxa were indentified as *Vetiveria lawsoni* (Hook. f.) Blatter & McCann (family Poaceae) and *Potamogeton crispus* L. (family Potamogetonaceae). The former taxon has so far been reported from Maharashtra, Karnataka and Tamilnadu (Blatter and McCann 1935, Fischer 1934) and the latter taxon was reported for the first time by Mathew (1982) from Tamilnadu as a new record for south India. Hence the present report of the occurrence of these taxa in Nizamabad district is interesting from the phytogeographical point of view and extends their distribution to Andhra Pradesh in south India.

Vetiveria lawsoni (Hook. f.) Blatter & McCann in J. Bombay nat. Hist. Soc. 32: 409. 1928; C. Fischer, Fl. Pres. Madras 3: 1201. 1957; Bor, Grass. Bur. Ceyl. Ind. Pak. 208. 1960. *Andropogon lawsoni* Hook. f., Fl. Brit. India 7: 187. 1896.

Perennial; root stock horizontal; culms to 1.2 m long, nodes distant. Leaves chiefly radical, 7-20 x 0.3-0.6 cm, rigid, subglabrous, apex acute-obtuse, margins ciliate; sheaths striate, to 12 cm. Inflorescence of 15-22 cm long panicle; racemes whorled. Sessile spikelets lanceolate, to 4 mm long, callus with silky hairs, upper glume awned, keel pectinately ciliate; lemma ciliate, obtusely 2-dentate. Pedicelled spikelets male, lanceolate, to 5 mm long, callus naked; stamens 3. Grains oblong, slightly oblique at top.

Flowering and fruiting: August - March.

Distribution: Nizamabad: Common in sandy localities throughout the district. INDIA: Maharashtra, Karanataka, Tamil Nadu.

Specimens examined: Chanapur, *BR* 7112; Jalalpur RF, *BR* 9564.

This taxon can be easily distinguished from the common species of *Vetiveria, V. zizanioides* (L.) Nash in having horizontal rootstock, leaves and panicles not exceeding 20 cm in length.

Potamgeton crispus L., Sp. Pl. 126. 1753; Hook. f., Fl. Brit. India 6: 566. 1983; Cooke in Fl. Pres. Bombay 350. 1908; Burkill, Rec. Bot. Surv.

India 4: 136. 1910; Mathew, Fl. Tam. Carn. 1715. 1982.

Perennial rhizomatous submerged herb; stem branched, compressed. Leaves linear or oblong-elliptic, 2-6 x 0.4-1 cm, membranous, translucent, 3-nerved, glabrous, base amplexicaul, apex rounded, margin crisped and serrulate; sessile; stipules to 4 mm, caducous. Flowers in 0.5-2 cm long spikes, dull-white ; peduncle to 5 cm long. Perianth lobes 4, clawed; stamens 4, ovaries 4, superior. Drupelets orbicular, to 0.2 cm. ridged, beaked, 1-seeded.

Flowering and fruiting: September - February.

Distribution: Nizamabad: rare in tanks. INDIA: Plains of India and temperate Himalaya (Cooke 1908).

Specimens examined: Belal tank, *BR* 7269.

This taxon is not mentioned in Fl. Pres. Madras. Mathew (1982) reported it as a new record, south of Madhya Pradesh (Central India).

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37. INDIAN DOUM PALM *HYPHAENE DICHOTOMA* IN KHANDESH — AN UNUSUAL OCCURRENCE

Doum palms are the only angiospermous taxa which show true dichotomous branching. The occurrence of the Indian doum palm *Hyphaene dichotoma* (Wt.) Furtado, was recorded from a few places on the west coast of India. Botanists have studied the morphology (Mahabale and Chennaveeraiah 1957), nature of branching (Greguss 1968), inflorescence (Rao and Korlahalli 1969, Bonde 1987), nutritional composition of fruit (Bonde *et al.* 1990) and distribution (Rao 1963, 1964; Meher-Homji 1970). According to Rao (1963), it is endemic to Diu, Daman, coast of Gujarat and north Maharashtra. While reporting this taxon, along the west coast of India, he cited a couple of localities (viz. Nagaon, Shirgaon) from Maharashtra in its distribution. These localities, however, clearly fall under coastal area. The present note records the new distribution, i.e. occurrence of *H. dichotoma* in West Khandesh, Dhule district, Maharashtra, in an area where the vegetation is predominantly dry scrub. So far, the present locality is the only non-coastal area for this species for the whole of Maharashtra. A couple of old plants and few seedlings grow in dry land near a small village, Methi, in Dhule district.

The entry of the west coast endemic palm to the present locality in West Khandesh which is very far from the former locality is curious. It, however, indicates the discontinuous distribution of the taxon. Discussion with locals indicates that a couple of plants may have been introduced to this locality about 30 years ago. Nevertheless, the present occurrence of this taxon is certainly unusual. The newly growing seedlings support the success of this species in the present locality.

Existing literature shows that the taxon is threatened in many of its natural habitats and facing extinction (Oza 1974, Rao 1963) and it has been included in the list of Threatened Plants of India (Jain and Sastry 1980, 1983). Its occurrence in Khandesh, however, indicates the possibility of extending its distribution. This endangered palm in Khandesh needs immediate protection and multiplication. The locality has been recommended to the Maharashtra

Forest Department for barbed-wire fencing as a preserved plot.

For the nomenclature of this taxon, we have followed Furtado (1970), who made new combination and adopted *H. dichotoma* as a correct name with *Borassus dichotoma* Wt. as the basionym for the present taxon.

We thank the College authorities for encouragement and help.

A. S. REDDY
T. S. PATIL

May 29, 1991

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38. ANOTHER LOCALITY RECORD FOR *CYATHEA SPINULOSA* IN KUMAON HIMALAYA

Taxonomic reports of various explorers, to date, indicate that there is only one plant of *Cyathea spinulosa* at Pamtori near Thal (Pithoragarh). Our exploration tour of Didihat (Pithoragarh) revealed that there are two instead of the one reported plant of the species at Pamtori near Thal. The two plants are located just 20 m from each other.

In addition we discovered another locality near Mirthy, 1300 m (Pithoragarh). This locality, situated along a ravine in a dense forest area contains approximately 30 plants of *Cyathea spinulosa*.

This rare fern faces the danger of extinction as the leaves are used for thatching house roofs by locals.

We wish to inform the concerned authorities that they should take necessary action to demarcate and protect the area containing this fern, in order to prevent extinction of the species.

H. C. PANDE
P. C. PANDE

May 25, 1991

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ARE CHITAL STAGS MORE VULNERABLE TO DHOLE PREDATION THAN DOES?[1]

AVIVA H. PATEL[2]

Johnsingh's 1983 study reveals that the dhole *Cuon alpinus* kills disproportionately more males than females of one of its prey, the sambar *Cervus unicolor*, but not of its other prey, the chital *Axis axis*. However, a re-examination of his data changed this conclusion. My analysis revealed that dholes do hunt significantly more male than female chital. What differed in my analysis was that I tested for differences between 22 month population sex ratios and 22 month kill sex ratios, whereas Johnsingh tested for differences between 5 month population and 22 month kill ratios.

INTRODUCTION

Johnsingh (1980, 1983) made a thorough and intensive study of the ecology and behaviour of the dhole or Indian wild dog *Cuon alpinus* Pallas, 1811 at Bandipur, concentrating on predator-prey relations. He studied populations of two of their prey, the sambar *Cervus unicolor* and chital *Axis axis,* and found a low sex ratio (defined as proportion of males) in both populations throughout the year; there were always more females than males in the wild. Sharatchandra and Gadgil (1978) conjectured that this might be because of higher mortality in males than in females, but did not provide any data for this suggestion. Johnsingh investigated whether or not dholes disproportionately prey upon more males than females. He concluded that dholes do kill more sambar males than females, but that there was no unequal predation of the sexes on chital.

However, a re-analysis of Johnsingh's data now indicates the reverse for chital predation, and reveals how a set of data can yield different results, depending on the interpretation. Johnsingh (1983) compared sex ratios of chital kills with those of chital populations in the wild. The kill sex ratio was the average for 22 months (the period of his study), but the population sex ratio was the average from only the 5 months that were the peak chital rutting season (May, June, July 1977 and June, July 1978, Johnsingh 1980). Table 2 shows the actual numbers used in his and my calculations. When he calculated the Z statistic on these ratios, he found that the 22 month kill ratio (64 males: 68 females, or 94 males per 100 females) did not differ significantly from the 5 month population ratio (84 males per 100 females).

ANALYSIS

I calculated several Z statistics using Johnsingh's data to test whether kill and population ratios of chital differed significantly. A summary of the tests and their results is shown in Table 1.

Test A, comparing 5 month kill ratios and 5

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TABLE 1

ANALYSIS OF JOHNSINGH'S DATA WITH RESPECT TO POPULATION AND KILL SEX RATIOS OF CHITAL

		R	N	Z	P
Test A	5 mo. kill ratio	0.636			
	5 mo. population ratio	0.455	22	1.71*	0.044
Test B	22 Mo. kill ratio	0.485			
	22 mo. population ratio	0.405	132	1.84*	0.031
Test C	22 mo. kill ratio	0.485			
	5 mo. population ratio	0485	132	0.70	0.242
Test D	5 mo. population ratio	0.455			
	22 mo. population ratio	0.405	3536	6.25*	<0.001
Test E	5 mo. kill ratio	0.636			
	22 mo. kill ratio	0.485	22	1.42	0.078

$Z=p1-p2/[p2(1-p2/N)]^{0.5}$ where p1 and p2 are proportions, and N=sample size. In each test, the null hypothesis was that the two ratios in that test did not differ at the 95% level of confidence.

R=sex ratio, Z=test statistic, P=probability associated with Z, $*=p<0.05$

month population sex ratios showed that more males than females were killed during the peak rutting season ($p<0.05$). This might be due to the fact that males are relatively indifferent to predation during the rutting season (Johnsingh 1983).

However, I also wanted to find out if the same pattern of preferential predation on stags occurred throughout the year. I therefore decided to use kill and population sex ratios obtained over the entire 22 month study. Test B, comparing 22 month kill ratios and 22 month population sex ratios, showed that more male than female chital were killed throughout the year ($p<0.05$), not just during the rutting season.

Test C was a replica of Johnsingh's test, comparing 22 month kill ratios and 5 month population ratios. It showed, as his test did, that chital males were not killed more often than females ($p<0.05$).

Test D was designed to find out whether there were indeed more males than females in the population counts during the periods of rut (5 months), compared to the rest of the study period. It revealed that indeed, significantly more males were seen during the months of rut than at other times of the year ($p<0.001$).

However, more males seen during the months of rut did not translate into more males killed during the months of rut. Test E showed that there was no difference between the kill ratios during the months of rut and during the rest of the 22 months ($p<0.05$).

Johnsingh notes that he used only a 5 month population ratio because stags were more visible during the two to three months of rut each year, and therefore more easily counted, than during the dry season. However, I believe that to be consistent in testing, the same time period should be used in calculating both ratios in a test. Johnsingh (1980) relies on 22 months of data for his kill ratios, so it seems reasonable to use data from the same timespan (22 months) to obtain population ratios. Although stags may be more aggregated and therefore more visible during May, June and July, it is important to obtain population counts from all the months of the year so that (1) the population ratio is not misleadingly biased toward males (as it would be if only the 5 month period were used); and (2) an estimate of the chital population as it varies over a whole year is obtained.

Tests A and B compared population and kill ratios over the same period of time: Test A over a 5 month period and Test B over a 22 month period. The results were significant in each case, and showed that stags were killed more frequently than does at all times of the year.

DISCUSSION

The results were somewhat surprising. They clearly indicated that dholes killed more chital stags than does throughout the year. Why should this be so? Johnsingh discusses various

reasons for the greater number of males found in prey statistics, which lead to greater numbers of females in the wild. Hornocker (1970) believes that males may be in a weakened condition after the rut and hence more prone to predation. However, Johnsingh (1983) provides kill data for chital stags in hard antlers showing that the numbers killed during the rut do not differ significantly from those killed at other times of the year. Sharatchandra and Gadgil (1978) observe that chital stags spend less time on the lookout for danger than does do. Johnsingh (1980) agrees, and adds that (1) stags in hard antlers often leave their herds and wander alone in search of estrous does; (2) dholes tend to avoid attacking herds of chital; and (3) stags in velvet, which do not rut but are killed as often as those in hard antlers, appear to be heavier than the latter, hence perhaps slower. Although hard data are required to verify these observations, it appears that stags may be more vulnerable to predation.

Johnsingh (1980) also mentions that stags with long antlers may be at a disadvantage compared to does when they flee from a coursing predator like the dhole. He provides data to show that a large proportion (70%) of stags killed had antlers longer than 70 cm, indicating perhaps that long antlers are a hindrance to stags in escaping from dholes.

Another intriguing possibility that needs to be studied further is that of optimisation of yield. Dholes may preferentially hunt stags because they are significantly heavier than does, and therefore provide more meat per kill effort than does or fawns. Data on meat per kill effort obtained from male and female prey would help test this hypothesis, as would direct observation

Table 2
KILL DATA FROM JOHNSINGH (1983)

Numbers of chital killed:	Males	Females
No. killed over 5 month (from Appendix B of Johnsingh 1980; used to obtain 5 month kill ratio)	14	8
No. killed over 22 month. (from Table 2, John singh 1983; used to obtain 22 month kill ratio)	64	68

of the hunt itself. If it is found that dholes do indeed prefer to hunt chital stags rather than does, the results would concur with other data indicating that males are preferentially hunted by coursing predators (Estes and Goddard 1967, Hornocker 1970, Wilson 1975).

The results of the above tests, combined with Johnsingh's data on sambar, indicate that dholes kill more male than female deer in the wild. At this point, it is not clear whether this is due to preferential predation on males by dholes or to the greater vulnerability of males to predation. Further research with larger samples, a variety of habitats and observations of actual hunting behaviour will greatly help in testing these hypotheses.

Acknowledgements

I would like to thank Dr. A.J.T. Johnsingh for his permission to analyse the data from his thorough and intensive study of predators and prey in Bandipur. Dr. R. Sukumar at the Centre for Ecological Sciences (CES) at Bangalore helped and guided me throughout, and CES provided resources. Drs. Carol Horvitz, Dave Janos and Doyle McKey at the University of Miami, and Dr. Sukumar at CES provided helpful comments on the manuscript.

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THE DISTRIBUTION AND STATUS OF THE LESSER FLORICAN *SYPHEOTIDES INDICA* (J.F. MILLER) IN THE INDIAN SUBCONTINENT[1]

Ravi Sankaran,[2] A.R. Rahmani and U. Ganguli-Lachungpa[3]

(With four text-figures)

The past distribution of the lesser florican *Sypheotides indica* was mapped based on an extensive literature survey. The present distribution and status was assessed from field surveys that covered the breeding range as well as non-breeding areas. The current status was evaluated by comparing the sizes of the past and current breeding ranges. The 1989 population was estimated at 750 birds, a decrease of about 80% from our 1982 estimate of 4374 birds. The reasons for the decline are discussed.

Introduction

The lesser florican *Sypheotides indica* (J.F. Miller) is a bustard endemic to the Indian subcontinent. Its popularity as a game bird resulted in frequent references to this species in late 19th and early 20th century natural history literature. Once the commonest and most widely distributed Indian bustard, this species is now becoming increasingly rare. Even as early as 1879, Hume and Marshal wrote, "Owing to the un-sportsmanlike manner in which these beautiful birds are massacred during the breeding season, they are everywhere diminishing perceptibly in numbers, and will, in another half century, be, I fear, almost extinct". With the extensive and intensive changes in land use practices, particularly over-grazing of its grassland habitat, the lesser florican appears to be seriously threatened with extinction.

The lesser florican breeds during the southwest monsoon, which normally begins by end June or early July. During this period, a distinct movement into Gujarat, eastern Rajasthan, western Madhya Pradesh and some parts of the Deccan is seen (Jerdon 1864, Dharmakumarsinhji 1950, this study). During the breeding season, males are very conspicuous both because of their nuptial plumage and their attraction displays, which can be heard up to 500 m away (Dharmakumarsinhji 1950, Ridley *et al.* 1985, Sankaran 1991). The breeding system of the lesser florican can be described as dispersed lek; males are territorial for two to three months and inter-territory distance varies from 200 to 500 m (Sankaran 1991). Females and immature males are inconspicuous and much more difficult to locate. The post breeding movements are still unclear. The lesser florican appears to disperse into suitable habitat over much of the Indian subcontinent, with the majority moving into southern India (Jerdon 1864).

Ali and Ripley (1983) described their habitat as "tall grassland with scattered bushes, and standing crops of cotton and millets..." The primary habitat requirement for breeding are grasslands where sufficient grass cover is available during the breeding season. In western India, the principal breeding range, these grasslands are of the *Sehima nervosum–Chrysopogon fulvus* type. Presently, such habitat is fragmented and patchily distributed throughout the species' breeding range; grassland patches that exist are protected by the government or by agriculturists for fodder. These are known as *Bheed*, *Veed*, *Vidi* or *Rakhaal* in different regions. The lesser florican also uses croplands of cotton *Gossypium* sp., sorghum *Sorghum vulgare*, maize *Zea mays*, soyabean *Glycine max* and sugarcane *Saccharum* sp., rice *Oryza sativa*, mustard *Brassica campestris*, groundnut *Arachis hypogea*, lentils and wheat *Triticium vulgare*. This species is also known to use lightly wooded country, grazed lands and scrublands dominated by *Zizyphus* spp.

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Objective: Our aim was to examine the shrinkage in the breeding range and population of the lesser florican and the causes for this reduction. We approached this through a synthesis of historical records, data collected during field surveys, and communications with interested individuals. We have attempted to place in one paper all such information available until April 1991.

Limitations in assessing status: An assessment of the status of the lesser florican is possible only during the breeding season, when males are conspicuous. The major limitation is that the species is nomadic and movements into and within breeding areas are dependent on the quantum and distribution of rainfall (Sankaran 1991). Thus, to determine the status of the lesser florican, the study must cover the entire breeding range in a single season, i.e. within two months. Furthermore, though floricans are found in greater numbers in large grasslands, they also establish territories or nest in small grasslands or in grass patches in between and within crop fields (Sankaran 1991). Thus within the breeding range it is possible to find lesser florican virtually anywhere. As the present breeding range could cover as much as 340,000 sq. km, the logistics make location of all major breeding concentrations impossible.

Variations in densities at a single site in different years must be interpreted cautiously, because densities at a site vary between years depending on the rainfall patterns. For example, the change in population at the Naulakha grassland at Sailana Florican Sanctuary (Ratlam district, Madhya Pradesh) — from about 12 in 1986 to 1-2 in 1987, and seven in 1989 — was due to the effects of rainfall and not necessarily because of a decline in the population (Sankaran 1991). Comparisons of densities between years can only be made when some idea of numbers over the entire breeding range is available.

Finally, the quantum of information available is small. This is due both to the scarcity of field ornithologists and the rarity of the species. We can only justify the speculations made in this paper on the grounds that in such a rare and endangered bird, with so wide a distribution and all the resultant logistic limitations of field research, one is forced to infer more from the data than may be normally acceptable.

Methods

The study consists of two parts, a literature review and surveys.

We conducted field surveys throughout the current breeding range of the lesser florican. Grasslands at discrete locations were surveyed on foot. Choice of grasslands was based mainly on information about floricans received from that locale. For example, in 1989 we surveyed grasslands where floricans had been seen in 1982. Since males are conspicuous during the breeding season, a direct count method gives an accurate picture of their numbers in a grassland. Counts were made in the mornings and evenings, at which time the frequency of male display is highest. A 100 ha. grassland can be effectively surveyed in about two hours by walking through it, listening for the characteristic display rattle; display may be performed as frequently as twice in a minute. All counts are therefore primarily of adult males seen or heard. Females were infrequently located; immature males never. Communications with other field workers, agriculturists and hunters during our surveys added considerably to the data.

Prior to this study, status surveys of the lesser florican were made in 1981 and 1982 (Goriup and Karpowicz 1981, 1985; Magrath *et al.* 1983, 1985; Yahya 1982, 1990). These provide the basis upon which the trends in population were assessed.

In this paper, the trend in the population was primarily inferred from the absence or presence of breeding individuals at different locations in the breeding range. The overall long-term decline in the population can be viewed within the perspective of reduction in size of the breeding ranges in the pre-1980 and the post 1980 years. Population trends over the last decade were inferred from two surveys, 1982 and 1989, which covered the same areas of the breeding range and

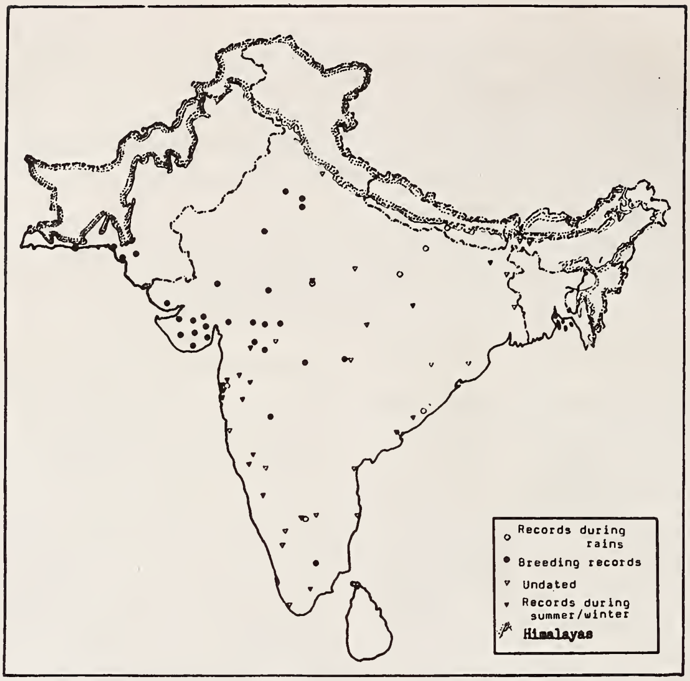

Fig. 1. Pre-1980 distribution of the lesser florican.

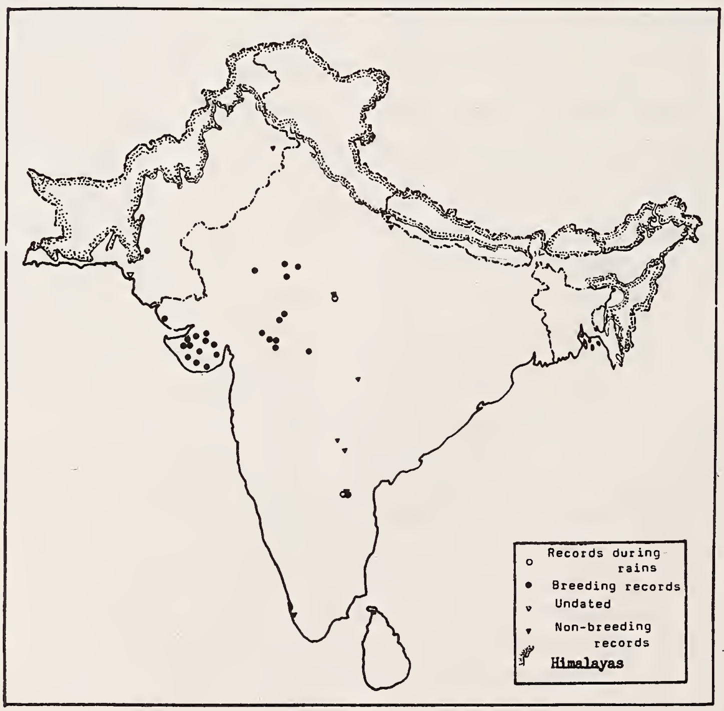

Fig. 2. Post-1980 records of the lesser florican.

shared several common breeding sites. Normal monsoons in both years make such a comparison reliable.

Due to the size of the area under consideration, we do not have data on the numbers or the area of grasslands in the present breeding range. Our calculations of the lesser florican population were based on the total area under grassland. The extent of grasslands present and the percentage used by lesser floricans is extrapolated over the entire breeding range based on data available in Magrath *et al.* (1983, 1985). Thus our estimates are based on the assumption that the areas and numbers of grasslands given by Magrath *et al.* (1983) are accurate and representative of the entire breeding range.

In this paper, a location, for example Belgaum, indicates areas around the town, often the district itself.

RESULTS

PRE-1980 DISTRIBUTION

The lesser florican occurred widely in the Indian subcontinent, from the Baluchi side of the Hab river in the west (Ticehurst 1927) to Malda and Jalpaiguri districts in the east (Inglis *et al.* 1920, Baker 1921), and from Trivandrum in the south (Ferguson 1904) to Sahranpur district in the north (Butler 1887). Thus, barring hilly, mountainous, densely forested or very arid areas the lesser florican was seen throughout the Indian subcontinent (Fig. 1, Appendix 1).

Most available literature on shooting and/or sight records is not specific. For example Butler (1880) records "...a few remaining about Belgaum all the year round", but does not state whether they bred there or not. Jerdon (1864) records them from the banks of the Ganges without mentioning specific locations. Thus, it is difficult to piece together an accurate picture of the breeding and wintering ranges. The available information has been categorized as: recorded as breeding; present during the south-west monsoon (but not specified as breeding); present during summer and/or winter (non-breeding season); and undated (Fig. 1). Details of locations are given in Appendix 1.

Breeding range: Breeding occurred between 17° and 29° N, and 62° and 79° E, an area that included much of western India. The breeding range covered suitable habitat in southern Sind (Pakistan), Gujarat, central, southern and eastern Rajasthan extending up to Hissar in Haryana, western Madhya Pradesh, northwestern Maharashtra, and extending south into the Deccan up to Solapur. There is a breeding record as far south as Trichy (Figs. 1, 3).

We interpret the available data as showing a distinct westerly, north-westerly and south-westerly movement from non-breeding areas into the breeding range during the monsoon. Though the breeding range covered a vast area, it is apparent that the principal breeding areas were the Kathiawad peninsula, eastern Gujarat, western Madhya Pradesh, north-western Maharashtra and south-eastern Rajasthan (Jerdon 1864, Hayes 1873, Barnes 1886, 1891; Davidson 1887). It was into and towards this region that the lesser florican migrated to breed during the monsoon.

Possibly due to a much larger population, and larger area of suitable habitat, considerable areas around the principal breeding range were also used for breeding. This possibly explains the breeding records from Haryana (Hume and Marshall 1879, Whistler 1914), coastal Makran and up to the western side of the Hab river (Ticehurst 1927), Solapur (Davidson and Wenden 1878) and Nagpur (McMaster 1817, D'Abreau 1935).

In addition to the principal breeding range and areas adjacent to it, the lesser florican was also recorded as resident and so presumably breeding from other parts of the Deccan in southern India. However, the only documented breeding record in south India is of a nest at Trichy (Tiruchirappalli) in October (Jerdon 1864). Jerdon also documented that a few birds breed in all parts of southern India, primarily from July to November, with nesting occurring till as late as January (but see Sankaran and Manakadan 1990).

Records during the south-west monsoon (July to October): Breeding occurs primarily during the monsoon. Those areas outside the known breeding range where floricans were seen

during the rains could have been breeding areas, though not specified as such in literature. More probably, these areas were used in passage en-route to the breeding range. However, the available data set is small, and a clear pattern does not emerge (Fig. 1).

Winter and summer records (November to June): During the non-breeding months, the lesser florican was generally found outside known breeding areas. Dharmakumarsinhji (1950) opined that they move into peninsular India once breeding was completed. Jerdon (1864) recorded an influx into the Deccan, particularly in south India, in October and November. However, both authors and others also mention that a few individuals are seen in the breeding range throughout the year. Most dated records from southern India are from the non-breeding months (Jerdon 1864, Butler 1880, Anderson 1883, Tostem 1887, Davidson 1898, Betham 1911, Whistler 1936, Nichols 1944).

In Maharashtra, the lesser florican was recorded on several occasions around Bombay and from other locations as well (e.g. Jerdon 1864, Davidson 1887, Khengarji 1909, Fellows 1918). It was present, albeit rarely, in western Madhya Pradesh (Jerdon 1864, Tyrrell 1910), and from northern and eastern Madhya Pradesh (King 1868, Ranjitsinh 1983).

In north and north-eastern India, the lesser florican was mainly seen in the summer. These include records from West Bengal (O'Donel 1913) and Bihar (Jerdon 1864, Baker 1921). Jerdon (1864) saw it in April-May along the banks of the Ganges.

Although a few birds remained within western India during the summer and winter, and breeding occurred in some locations in southern India, we interpret the available data as showing a dispersal away from the breeding range (western India) into northern, eastern and southern India. There appears to be a nomadic dispersal rather than a distinct migratory pattern. It is probable that the majority of the birds disperse into southern India, along the Deccan plateau (see also Jerdon 1864).

Post 1980 Distribution

Recent information on the lesser florican was obtained from surveys done in 1981, 1982, 1984, 1986 and 1989, literature records as well as personal communications with naturalists.

In 1981 a brief status survey was conducted in parts of the Kathiawad peninsula in Gujarat, one location near Ajmer in Rajasthan, some areas in central India around Nagpur, and one location in southern India (Goriup and Karpowicz 1981, 1985). Two surveys in 1982 covered three districts in the Kathiawad peninsula in Gujarat (Magrath *et al.* 1983, 1985), and some parts of central India and the Malwa plateau (Yahya 1982, 1990). Between 1984 and 1989 we conducted six surveys, four in the breeding range (Gujarat, western Madhya Pradesh and eastern Rajasthan) and two in southern India. Rajasthan was surveyed in 1984 and 1986, the Malwa plateau in 1984, 1986 and 1989, and the Kathiawad peninsula and Kutch in 1989. In the continuum of potential breeding areas from the Kathiawad peninsula in the west to the Malwa plateau in the east, the central portion, i.e. central Gujarat, is densely populated and industrialized or intensively farmed, and hence was not surveyed. Moreover, there were no recent reports from those areas. Details of surveys are given in Appendix 2.

Breeding records: Between 1980 and 1990, the lesser florican was recorded breeding in those parts of western India that can be considered their principal breeding grounds (Fig. 2).

During the surveys of the Kathiawad peninsula in 1981 and 1982, they were recorded breeding in some numbers (Goriup and Karpowicz 1985, Magrath *et al.* 1985; Fig. 2). The three year drought in western Gujarat between 1985 and 1987 resulted in an absence of breeding birds in the region during that period. In 1989, despite normal monsoons, very few birds immigrated into or bred in the Kathiawad peninsula. Only one small breeding population was seen in coastal Kutch (Kuchch).

The Malwa plateau in Madhya Pradesh has been regularly surveyed between 1982 and 1989

TABLE 1
SUMMARY OF SURVEYS – 1981, 1982, 1984, 1986, 1989

	Malwa plateau				Kathiawad peninsula		
	1982	1984	1986	1989	198	1982	1989
Total no. of floricans sighted	34	47	91	31	22	78	14*
Total no. of grasslands surveyed	12	11	20	12	50	81	43

* reported to us, not sighted during the survey

(Table 1). Barring 1987, which was a drought year, the lesser florican was found to be locally common in several locations in the Malwa plateau (Fig. 2). In the Nimar region, breeding has been reported near Sendhwa on the Madhya Pradesh-Maharashtra border; those areas have not yet been surveyed.

In Rajasthan, breeding was recorded in Bhilwara and Tonk districts and around Ajmer, just east of the Aravalli range. On the fringe of the Thar desert, the lesser florican has been reported as breeding in Pali district (Ishwar Prakash, pers. comm.).

In Maharashtra, however, breeding has not been recorded in areas where the species bred earlier. Around Nagpur, no breeding has been recorded in recent years (Goriup and Karpowicz 1985, Yahya 1982, 1990). Between 1981 and 1985, no breeding was recorded at Solapur; only two sightings exist from that area from the same period (Manakadan, R. pers. comm.)[4].

Further west, the lesser florican has been recorded breeding sporadically in Sind, Pakistan (T.J. Roberts, pers. comm.).

Breeding was also observed at the Rollapadu Bustard Sanctuary in Kurnool district of Andhra Pradesh in the winter of 1987. This, however, has been postulated as being a response to drought conditions in western India that year (Sankaran and Manakadan 1990, Sankaran 1991).

Records during the south-west monsoon (end June–early October): Very few records exist outside known breeding areas. Sightings during the monsoon have apparently been of birds in transit towards western India. For instance, at the Karera Bustard Sanctuary in northern Madhya Pradesh, floricans were seen occasionally in June, July and August. Males in breeding plumage did not display, and breeding has not yet been recorded from that region. In Andhra Pradesh, between 1986 and 1989, lesser floricans were seen four times at the Rollapadu Bustard Sanctuary in June, July and August but neither display nor nesting was recorded (Fig. 2).

Winter and summer records (mid October-June): The recent records during the post and pre-monsoon months are also scanty but corroborate our interpretation of the non-breeding range from the literature review.

Floricans have been seen in the terai of Uttar Pradesh and Nepal (Sankaran and Rahmani 1988, B.B. Thapa, pers. comm.). One female was seen frequently at the Karera Bustard Sanctuary in January 1984. Likewise, a female was trapped near Nagpur in January 1982. There is also one record in the summer from the *doab* between Ravi and Degh rivers north of Lahore in Pakistan (T. J. Roberts, pers. comm. 1989)

Most records in the winter and summer are from Andhra Pradesh (Siraj Taher, pers. comm., Sankaran and Manakadan 1990). Local information revealed that the lesser florican was seen in several locations in the Kurnool, Guntakal, Bellary and Raichur areas of Andhra Pradesh and Karnataka, particularly in the winter. Further south a female was caught in Quilon district of Kerala (Krishnan 1990).

STATUS OF THE LESSER FLORICAN

Comparison of pre- and post 1980 breeding ranges: The pre-1980 and post 1980 breeding ranges of the lesser florican are shown in Fig. 3.

[4] One male in non-breeding plumage was seen on 2 June 1992 at Nanaj, Solapur.

For simplicity, the outermost breeding locations have been connected to form a polygon. The breeding records in southern India have not been considered (see above; Sankaran and Manakadan 1990, Sankaran 1991). Historically too, southern India was not considered as the principal breeding range (Jerdon 1864, Hume and Marshal 1879).

The breeding range of the lesser florican has shrunk to 40% of its original size (Fig. 3). This species now breeds only in what can be regarded as the core of the historic breeding range; and even here, nowhere as commonly as before. In the 1980s, floricans bred in some numbers only in the Malwa plateau, the Kathiawad peninsula and in parts of eastern Rajasthan.

Breeding status: A comparison of 1982, 1986 and 1989 surveys: Table 1 summarises the data from the 1982, 1986 and 1989 surveys. While the breeding areas in Malwa that were used in 1982 continued to be used in 1989, the case was not the same in the Kathiawad peninsula (Table 1, Fig. 4).

In 1989, we surveyed well protected grasslands where floricans were seen in some concentrations in 1982, but they were not present in 1989 (Table 1). Their absence was further verified by local *vidi chowkidars*, who strongly asserted that floricans were absent, especially in Bhavnagar, Junagadh and parts of Jamnagar. However, a few isolated records particularly in Rajkot and parts of Jamnagar indicated that a few individuals were present. Barely one or two locations reportedly had territorial males. Thus, while the odd individual must have been missed during the survey, what was significant was the total absence of breeding concentrations in the Kathiawad peninsula in 1989. The only exception was a small breeding population in Kutch (Fig. 4).

In all grasslands surveyed in 1989, where floricans were located in 1982, the conditions for breeding were suitable; a result of normal monsoons. During normal rainfall conditions, breeding concentrations should have been present if the population had remained stable between 1982 and 1989. The lack of sightings of breeding males in the Kathiawad peninsula can therefore be attributed to a significant drop in numbers.

This drop in population is also reflected in the Malwa plateau, the core of the breeding range. Though breeding males were seen in all surveyed sites in all years, the drop in numbers is seen when 1986 and 1989 are compared. The 1986 drought in Kathiawad resulted in a concentration of males in the Malwa plateau (Sankaran 1991). In 1989, though Kathiawad had normal rains there were very few floricans there. Thus both in 1986 and 1989 the florican was present in significant numbers only in the Malwa plateau, as dispersal over other parts of the breeding range was very low or absent. Thus the trends in population can be gauged by comparing populations at two separate locations in the Malwa plateau in these two years.

In 1986 and 1989, eight grasslands around Sailana were thoroughly surveyed. In 1986, 40 territorial males were located while in the same grasslands only 19 territorial males were located in 1989. In Dhar district, three grasslands were common to the 1986 and 1989 surveys. In 1986 at these three sites, 40 male floricans were either seen or reported (P.M. Lad, pers. comm. 1986), while in 1989 only 18 males were seen or reported.

Population estimate: Approximately 65 males were seen/reported during the 1989 survey. In the Malwa plateau, 31 males were seen in Ratlam, Dhar and Jhabua (Appendix 2) and 15-20 at Dohad; nine males were reported from the Kathiawad peninsula and about five in Kutch. Assuming an equal sex ratio, the number of birds seen in the surveyed areas would be about 130.

TABLE 2

POPULATION ESTIMATE OF THE LESSER FLORICAN

Year	Total grassland area (sq. km)	Suitable grassland area	Male density per sq. km	Total male population	Total population
1982	7364.3	1914.72	1.142	2178	4374
1989	7364.3	1914.72	0.196	37	75

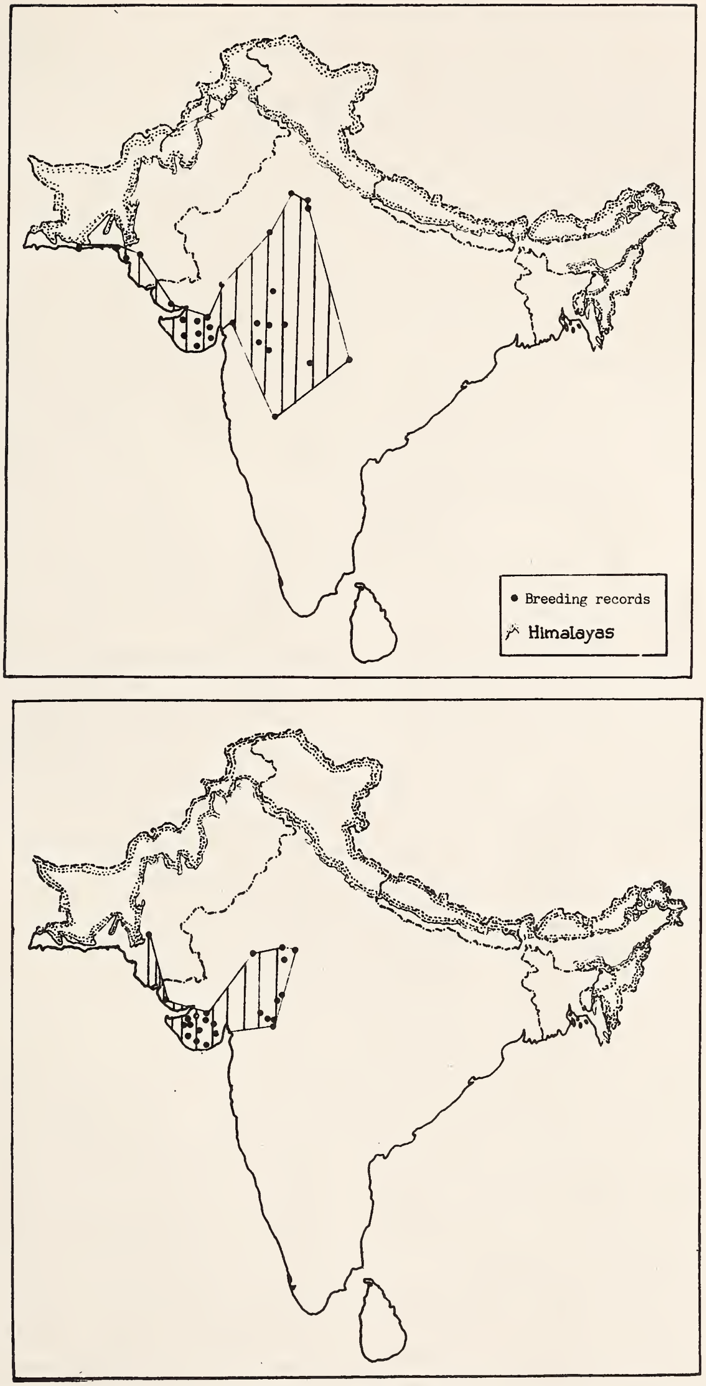

Fig. 3. A comparison of the pre-1980 (above) and post-1980 (below) breeding ranges of the lesser florican.

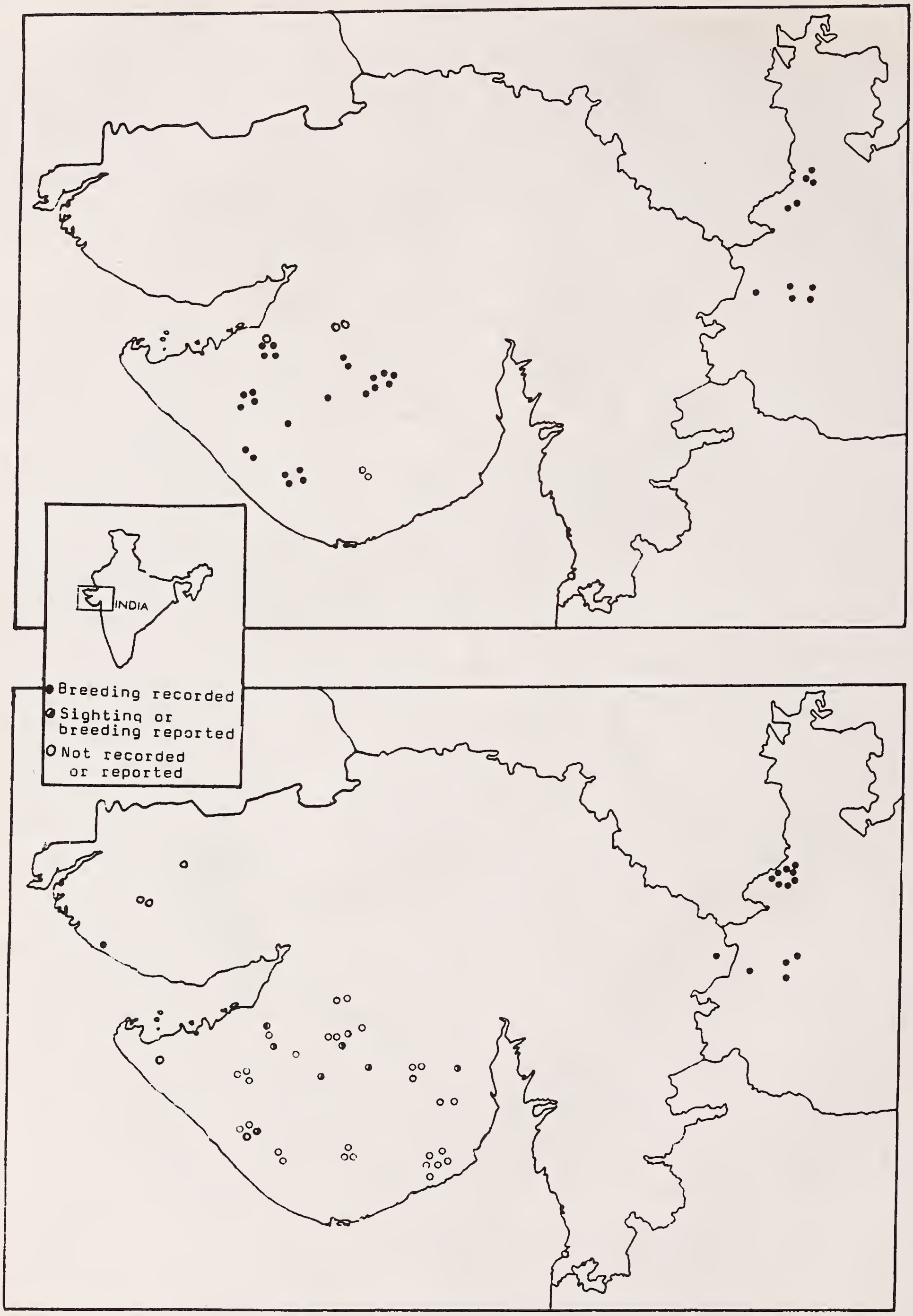

Fig. 4. A comparison of breeding records from localities surveyed in 1982 and 1989.

The steps leading to a population estimate for 1989 are given in Appendix 4. We estimate a population of 750 birds in 1989 (Table 2). Magrath *et al.* (1983, 1985) used number of grasslands rather than grassland area in their estimate, and estimated a population of 362 birds in three districts of Gujarat in 1982. The populations in these three districts were re-estimated using our method at 458 birds, 21% over their estimate. We extrapolated the data collected by Magrath *et al.* (1983, 1985) over the entire breeding range, and estimated the 1982 population by our method as 4374 birds. Thus the reduction in population between 1982 and 1989 has been to the tune of 80%.

Reasons for Decline

Habitat loss: India supports the largest livestock population in the world. This has grown from 292.02 million in 1951 to 415.94 million in 1982, an increase of 70.2% (Prasad and Bhatnagar 1988). Likewise, the area under agriculture has also increased. The net result has been that the grassland habitat available to the lesser florican has decreased considerably over the years. For instance, Jamnagar district of Gujarat alone had 1,619 sq. km of area classified as grassland in 1929-1930, (though what proportion of this was ungrazed or lightly grazed is unknown), which by 1981 had decreased to 76 sq. km under government control (Goriup and Karpowicz 1985). The fall in lesser florican numbers has been simultaneous with the loss of habitat in its breeding range.

Currently all optimal breeding habitat of the lesser florican occur as fragmented pockets that rarely exceed 1000 ha. Privately owned grasslands are small (Range 4–350 ha., avg. 117 ha., n = 30). This sample is only of large grasslands. Innumerable patches occur, upwards of one eighth of a hectare, that are scattered throughout croplands. Government owned grasslands are larger (Range 22–2700 ha., avg. 532 ha., n = 53). Government owned grasslands are of two kinds: reserved and non-reserved. The former is strictly protected from grazing while non-reserved grasslands do not receive protection and are freely grazed. Non-reserved grasslands are far more in number (at least 2-3 times) than reserved grasslands, but because of an absence of vegetation, are rarely used for breeding.

Habitat loss must have been a major reason for the overall decline of this species. The fall in numbers over the last decade, however, cannot be attributed primarily to habitat loss. The 1989 survey specifically examined grasslands where lesser floricans were present in 1982. The degree of protection from grazing, the extent of the grasslands, and the land use patterns had not changed perceptibly at these sites. Grasslands occur throughout the breeding range and their extent and status has not changed sufficiently to explain the drop in population between 1982 and 1989.

Hunting: There are many examples of a species being hunted to extinction by man. Hunting has been a major factor for the rapid decline of the lesser florican. In the past, lesser florican shooting excursions were common and very widespread. Bags of 10 or more birds were common during the breeding season in a morning's shoot. Photographs in the JBNHS (Baker 1912), show two bags, one of 10 males and the other of four males and two females, these perhaps being the only published photographic evidence of lesser florican shoots. Clearly, in the breeding season, a strong bias existed towards the shooting of males as they are territorial and conspicuous.

Magrath *et al.* (1983) doubted whether hunting was the major reason for the decline of the lesser florican because: (1) floricans were heavily hunted prior to 1947 without obvious effects, (2) hunting affected mostly males which in this promiscuous species may have been a harvestible surplus, (3) the decline has been mainly on farmland.

We believe, however, that hunting has played a major role in directly reducing populations because: (1) hunting pressures prior to 1947, as early as mid 1800s had prompted many to document their perceptibly decreasing numbers (e.g. Hume and Marshal 1879, Baker 1912); (2) During the breeding season floricans were not

shot incidentally, but specifically, with such 'organised' hunts occurring frequently. During the breeding season the male population of entire grasslands were decimated in a morning's shoot. Re-colonisation of newly vacant territories resulted in such planned hunts occurring repeatedly within a season. Additionally, males were snared at display sites, and females trapped on the nest. Outside the breeding season floricans were shot whenever found. The strong bias towards the hunting of males in the breeding season was absent during the non-breeding season, when both sexes were equally inconspicuous.

Hunting, with guns or snares, continues to be widespread. In fact, absence of floricans from certain areas during the 1989 survey was corroborated by local hunters who had specifically sought the bird that season but failed to see any.

Drought: The entire breeding cycle of the lesser florican is dependent on the south-west monsoon (Sankaran 1991). Sub-optimal rainfall results in poor breeding responses and drought results in a failure to breed (Sankaran 1991). Thus protracted drought conditions are the single largest natural threat to this species.

Drought in western India is in our opinion the primary cause for the significant drop in population between 1982 and 1989. This drought lasted for three years (1985 to 1987) in Gujarat, and for one year (1987) all over western India, which during the same period experienced one year (1985) of sub-optimal rainfall. Up to 1984 the floricans occurred widely over the breeding range and were locally common in many areas. Post drought populations were perceptibly smaller than populations in the pre-drought years.

We find corroboration in the observations of *vidi chowkidars* in Gujarat. They noted the presence of floricans prior to the droughts, in some areas in 'good numbers', but since the drought they have been absent or rarely seen.

Pesticides: Insects form a large part of the diet of the lesser florican. The birds extensively use crop fields during the breeding season and presumably throughout the year. The effects of the indiscriminate use of pesticides in agriculture on the lesser florican, is unknown.

Non-breeding season mortality: The wintering movements are still poorly understood (Sankaran and Rahmani 1986). Grassland habitat in peninsular India are almost completely denuded, particularly in summer. The effect of the loss of cover on the lesser florican is unknown. One factor that may have contributed to their overall decline may have been a high non-breeding season mortality. Magrath *et al.* (1983) refuted this because they found high occupancy rates in suitable grasslands, which implied that the population was limited by factors within the breeding season.

The drift towards extinction: If the area over which a species breeds is indicative of its population, then the extent of reduction of the breeding range is also indicative of the degree of reduction in population. In 1989, in spite of normal rainfall, the lesser florican bred in some numbers only in the Malwa plateau, the core of its former breeding range. Its rarity or absence from areas that were used extensively up to 1982 (possibly up to 1984), is strong indication of an abrupt drop in populations. Only one conclusion can be drawn from the 1982 and 1989 population estimates and the shrinking in the breeding range: that this species is under a severe threat of extinction.

Gilpin and Soule (1986) classified extinction into two kinds, deterministic and stochastic. They noted that many extinctions are the result of deterministic events (e.g. habitat loss or over-hunting) which reduces the population to a size range where stochastic events (e.g. severe droughts) terminate it. The decline in the population of the lesser florican is clearly identified with this process. We identify two deterministic events that have resulted in an overall decline in lesser florican numbers: habitat destruction and sex-biased over-hunting.

The widespread destruction of grassland habitat has resulted in a fragmentation of breeding habitat. As the species is nomadic and disperses over a wide area during the breeding season (Sankaran 1991), fragmentation and patchy dis-

tribution of breeding habitat would result in an increased search time both for mates and for optimal breeding habitat. This would cause delays in initiating breeding. Moreover, in such patchily distributed habitat there could also be increasingly higher proportions of individuals nesting in sub-optimal habitats (e.g. in cropfields) which could decrease hatching success or survival rates of young.

Sex-biased over-hunting alters sex ratios, which could lead to a greater variation between birth and death rates due, for instance, to increased difficulty in finding mates (Gilpin and Soule 1986).

The above two causes of deterministic extinction steadily reduced the lesser florican population, but till 1982 they were still not in immediate danger of extinction (Magrath *et al.* 1983, 1985).

Environmental perturbations usually thin a population but do not destroy it; once thinned, a population is at increased risk from the same or from a different kind of random event (Gilpin and Soule 1986). Thus in this species the deterministic extinction process resulted in the lesser florican being vulnerable to any major random event. The lesser florican has survived one such random event, the drought between 1985 and 1987, with a significant fall in population. However, deterministic processes continue to exist, which probably preclude any possibility of the species recovering to a number capable of withstanding another major environmental perturbation. With a considerable part of western India being drought prone (in some areas a drought is expected once in three years), we believe that the lesser florican now faces the real threat of stochastic extinction.

Conclusion

Extensive loss of habitat and severe hunting pressures have been the primary causes for the continuous decline in population of the lesser florican over the last several decades. We now believe that the 1982 perception of the lesser florican's status stands altered. The species is now under an increased threat of extinction. This change in status can be attributed largely to the droughts in western India between 1985 and 1987. The threat from habitat loss and hunting continues, further threatening the species. We believe that in all probability the population has fallen well below levels from which it can recover; that the species is drifting steadily towards extinction.

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APPENDIX 1
PRE-1980 DISTRIBUTION OF THE LESSER FLORICAN – A LITERATURE REVIEW

Place	No. of birds, other details	Date/Season	Source
Rajasthan			
1. Sambhur Lake	Male	July 19	Adams 1873
	Female	Start of rains	Adams 1874
2. "Rajpootana"	–	Sept-Oct	Barnes 1886
"Rajpootana"	Very common	–	Barnes 1891
"Rajpootana"	Breeds	July-Sept	Jerdon 1864
Gujarat			
1. Deesa	7-8	Rains	Butler 1876
2. Baroda	Eggs-chicks	Aug-Sept	Littledale 1886
3. "Gujarat"	–	–	Barnes 1891
4. "Kathiawar"	–	–	Anon. 1908
5. "Wadhwan"	One female, 3 juveniles	Nov. 1, 1908	R.K. 1909
6. Kathiawar	Abundant	Rains	Hayes 1873
7. Saurashtra	489 ringed	Rains (1943-49)	Dharmakumarsinhji 1950, 1954
8. "Gujarat"	Very common	June-Sept	Jerdon 1864
9. Panch Mahal	One	Before 1912	Baker 1912
10. Kutch	"plentiful"	Rains	Palin *et al.* 1904
11. Gujarat, Kathiawar, Kutch, Rajkot	–	Rains/breeding	Hume & Marshal 1879
Maharashtra			
1. Karjat Bhor Ghat	Female	Jan 20, 1935	Prater 1935
2. Ratnagiri	One		Vidal 1880
Lavel & Chiplun	Two		Vidal 1880
Dapuli	One		Vidal 1880
3. Solapur	Common	–	Butler 1880
Solapur	Common	Sept-Oct	Davidson & Wenden 1878
Solapur	'many'	Rains/breeding	Hume & Marshal 1879
4. Erandole (Dharamgaon)	Moderate numbers	–	Davidson 1887
Dharamgaon	Common	Rains/breeding	Hume & Marshal 1879
5. Kapurna (Dhulia)	Common	–	Davidson 1887
6. Nandurbar	Occasionally	Cold weather	Davidson 1887
7. Bombay	Juv. male	–	Abdulali 1969
Bombay Presidency	–	Aug.-Sept.	Barnes 1885
8. Nagpur	–	Aug-Sept	D'Abreau 1935

Place	No. of birds, other details	Date/Season	Source
9. Ratnagiri	Rare	–	Barnes 1891
10. Panvel	One female	Jan 17, 1909	Symons 1909
11. Mahalaxmi, Bombay	One	1899	
12. Satara	Female	Nov. 21, 1908	Khengarji 1909
13. Madhwa-Alibaug	Female	Dec.16, 1912	Kinnear 1913
Chiplun, Ratnagiri	One	Feb.7, 1913	
14. Mahabaleshwar	One	Apr. 1915	Fellows 1918
15. Parel (Bombay)	Female	Sept.4, 1918	Marryat 1918
16. Andheri-Malad (Bombay)	One	Dec. 1912	Suter 1913
17. Chinchavli-Neral	Female	Nov. 1908	
18. Churchgate Station	One	June, 8 1913	Times of India
Kalyan	One	Dec 1912	10 June 1913
19. Akola	Male	August	McMaster 1817
20. Nagpur	Male	Oct 28	
21 'Deccan'		Cold season	Jerdon 1864
22. Wardha/Chanda	Rare	–	Blanford 1871
23. Khandesh		Probably	
Nasik	Common	throughout	
Ahmednagar		the year	Hume & Marshal 1879
Western parts of	–		
'Central provinces'		Rains/	
Khandesh	–	breeding	
Madhya Pradesh			
1. Neemuch	–	Sept-Oct	Barnes 1886
2. Sirguja	Female	Jan	Ball 1874
3. Sardarpore	Three	Apr 1910	Tyrrell 1910
4. Indore	Male	Aug-Sept	Ali 1939
Sardarpur	2 males	1938	
5. "Central Province"	–	Aug-Sept	D'Abreau 1935
6. Nimar	–	–	Hewetson 1955
7. Goona (Guna)	–	Mar-Dec 1867	King 1868
8. "Central India"	–	Rains	
9. Malwa (Ratlam)		"	Jerdon 1864
10. Indore		"	
11. Saugor (Dhar)	Few	Hot weather	
12. Kanha	Female	June 1969	Ranjitsinh 1983
13. Western parts of 'Central Provinces' & 'Central India Agency'	–	Rains/breed	Hume & Marshal 1879
Haryana			
1. Rohtak	Common	Monsoon	Hume & Marshal 1879
Gurgaon	Common	Monsoon	
2. Hissar	One male	July 1913	
	Two males	Aug 8, 23	Whistler 1914
	One male	Sept 6, 24	

Place	No. of birds, other details	Date/Season	Source
Uttar Pradesh			
1. Allahabad	One pair	July 16, 1881	Markham 1887
2. Saharanpur (Koomarheira)	One	1872	Butler 1887
3. Gorakhpur	Small nos.	Rains	Osmaston 1913
4. Ganges Bank	–	Apr-May	Jerdon 1964
5. 'Oudh'			
Sultanpur	Single	–	
Lucknow	specimens		Hume & Marshal 1879
Meerut district			
Etawah district			
6. Jhansi	Common	–	Hume & Marshal 1879
Bihar			
1. Purnea	Occasional	May-June	Jerdon 1864
2. Purnea & Nuddeah	Straggler	Apr-May	Baker 1912
West Bengal			
1. Hasimara Estate	A male	June 1911	O'Donel 1913
2. Nuddea	One	Apr-May	Baker 1912
3. Neora Nuddy Estate	?	–	Inglis *et al.* 1920
4. Malda	–	–	Hennessy 1912
Orissa			
1. Sambalpur	Several	–	Ball 1876
2. South of Mahanadi	–	–	Ball 1878
3. Cuttack	One	–	Blanford 1898
Andhra Pradesh			
1. Rajamundhry	A female	June 1881	
Rajamundhry	3-4	Dec-Jan	Tostem 1887
2. Nellore	'Plenty'	–	
3. Coconada (Samulkotta)	4-5	–	McInroy 1879
4. Waltair (Razan)	1	–	Cox 1899
5. Godavari district	–	–	
Godavari district	A female	June	Whistler 1936
6. Northern Circars	–	–	Jerdon 1864
Karnataka			
1. Dharwar	Common	–	
2. Belgaum	Few	All year	Butler 1880
3. Mysore	One	1928-43	Ali 1943
4. "Kanara"	Rare	–	Barnes 1891
5. Bangalore	One	14 Dec 1911	Betham 1911
6. "Mallur"	30	–	McInroy 1879
7. East Mysore	Numerous	–	
8. Halyal, North Kanara	1-2	April	Davidson 1898
9. Tumkur	One	Before 1912	Baker 1912

Place	No. of Birds	Date/Season	Source
10. South Kanara	–	Cold weather	
Mysore		October to	Jerdon 1864
		Feb-Mar	
11. Bangalore	'Numerous'	Rains &	
		Cold weather	Anderson 1883
Shimoga	Good many	Hot weather	
12. Belikeri	Female	–	Abdulali 1969
Tamil Nadu			
1. Sholavandan, Madura	One	March 20, 1904	Nichols 1944
2. Madras	One	--	Whistler & Kinnear 1935
3. Trichi	Nest	October 1935	
4. Trichi	Female	October	Jerdon 1864
5. Nilgiri slopes	One	–	Davison 1887
6. 'Madras' (Tamil Nadu)	–	–	Aflalo 1904
7. Carnatic	–	Oct to Feb-Mar	Jerdon 1864
Kerala			
1. Trivandrum	One	1876	Ferguson 1904
2. Malabar Coast	Few	July-Nov	Jerdon 1864
Pakistan			
1. South-western Corner of Sind	–	Good Monsoons	
Gadap	–		
Sapoora	–		Ticehurst 1924
Moach plains	8 shot	August	
Upper Sind	Few	Cold weather	
2. Eastern coastal Makran	–	–	
Baluchi side of Hab river	15	Rains	Ticehurst 1927
Ormarra	2		
Gili, Hungol River	1	10 Sept.	
4. Sapoora, Baluchi side of Hubb river	–	Aug.-Oct.	Hume 1875
5. Hubb plains	1 egg	–	Murray 1890
6. Around Karachi	10-30 couples	Aug. & Sept.	Hume 1873
Nepal			
1. South-east of Patan, Kathmandu valley	3	Monsoons	Fleming *et al.* 1979
Burma			
1. Sandoway, Arrakan coast	1	–	Anon. 1835 cf. Jerdon 1864

APPENDIX 2

POST 1980 DISTRIBUTION OF THE LESSER FLORICAN — A SUMMARY OF STATUS SURVEYS

District	Taluk/ Village	Grassland Name	Grassland area (ha)	Ownership	No. reported in 1981	No. reported in 1982	No. reported in 1989	Remarks
GUJARAT								
Bhavnagar		Velavadar	2000	1	n.v.	n.v.	(2)	Few visit every year
Bhavnagar	Ghadada	Khantaliya	(225)	1	n.v.	n.v.	0	
Bhavnagar	Ghadada	Nanasariya	106	1	n.v.	n.v.	0	
Bhavnagar	Ghadada	Dudapur	84	1	n.v.	n.v.	0	
Bhavnagar	Pipala	Pipala	687	1	n.v.	n.v.	0	
Bhavnagar	Shehore	Chorwadla	886	1	n.v.	n.v.	0	
Bhavnagar	Mahuwa	Sangway	(75)	3	n.v.	n.v.	0	
Bhavnagar	Mahuwa	Ranigado/Hipavali	(1000+)	1,3	n.v.	n.v.	0	Present in the past
Bhavnagar	Mahuwa	Nanivadal	555	1	n.v.	n.v.	0	
Bhavnagar	Mahuwa	Matda	(70)	1	n.v.	n.v.	0	
Bhavnagar	Mahuwa	Gebar	726	1	n.v.	n.v.	0	Present in the past
Bhavnagar	Mahuwa	Mithiala	1077	1	n.v.	n.v.	0	Present in the past
Amreli	Khambha	Rabarika	875	1	n.v.	n.v.	0	
Amreli	Dhari	Sarasia (E)	1059.75	1	n.v.	0	0	
Amreli	Dhari	Sarasia (W)	(1000)	1	n.v.	0	0	
Amreli	Dhari	Chathadia	n.a.	1	n.v.	n.v.	0	1 in 1987
Junagadh	Sasan	Malanka/Zinzudar/ Nataliya/Kodia	791	1	n.v.	12	0	
Junagadh	Sasan	Mota Babra/ Amaridhar/ Mohabatgadh	696	1	n.v.	3	0	
Junagadh	Sasan	Lakada	105	1	n.v.	2	n.v.	
Junagadh	Sasan	Nana Babra	875	1	n.v.	n.v.	0	
Junagadh	Manavadhar	Sadarghad	21.15	1	n.v.	2	0	
Junagadh	Manavadhar	Dadamdhar	50.55	1	n.v.	2	0	
Junagadh	Manavadhar	Dadwa	n.a.	1	n.v.	n.v.	0	Possibly 1 in Aug. 1989
Junagadh	Manavadhar	Sehdi/Untari/ Zinzari	123	1	n.v.	n.v.	0	
Jamnagar	Pipartoda	Pipartoda	103	1	1	1	0	1 in August 1989
Jamnagar	Pipartoda	Khatia	350	1	3	3	0	1 male in 1989
Jamnagar	Pipartoda	Kengarpur	301	1	n.v.	10	0	2 in July 1989
Jamnagar	Ranjitsagar	Harshadpur	50	2	4	4	n.v.	
Jamnagar	Jamnagar	Sapa	(265)	2	1	0	n.v.	

District	Taluk/ Village	Grassland Name	Grassland area (ha)	Grassland Ownership	No. reported in 1981	No. reported in 1982	No. reported in 1989	Remarks
Jamnagar	Bhatia	Gaga	n.a.	1	n.v.	n.v.	0	
Jamnagar	Jamjodhpur	Mahiki	121	1	2	3	0	
Jamnagar	Jamjodhpur	Sadodad	434	1	7	3	0	2 in 1988
Jamnagar	Jamjodhpur	Moti	550	1	4	5	0	
Jamnagar	Jamjodhpur	Devria	n.a.	2	n.v.	2	n.v.	
Jamnagar	Kalavad	Jamvadi	900	1	n.v.	n.v.	0	
Jamnagar	Dhoraji	Rampar	160	1	n.v.	3	n.v.	
Rajkot	Rajkot	Kirasara	n.a.	1	n.v.	n.v.	0	
Rajkot	Rajkot	Bhadwa	n.a.	2	n.v.	n.v.	0	2 in 1989
Rajkot	Rajkot	Ghadka	n.a.	2	n.v.	n.v.	0	
Rajkot	Rajkot	Pal	20	2	n.v.	1	n.v.	
Rajkot	Rajkot	Vadali/Lothad/ Mahajan	(600)	2	0	1	n.v.	
Rajkot	Rajkot	Mahika	n.a.	2	n.v.	n.v.	0	
Rajkot	Gondal	Umwada	n.a.	2	n.v.	n.v.	0	
Rajkot	Jasdan	Jasdan	(50)	2	n.v.	n.v.	0	1 sighted in June 1989
Rajkot	Jasdan	Bhandaria	167	1	n.v.	3	n.v.	
		Maika I	100	2	n.v.	6	n.v.	
		Maika II	80	2	n.v.	3	n.v.	
		Umbawara	350	2	n.v.	4	n.v.	
		Wadadhari	117	1	n.v.	1	n.v.	
Rajkot	Wankaner	Rampara	1902	1	0	0	0	
Rajkot	Wankaner	Tithwa	127	1	0	2	0	
Surendranagar	Anandpur/ Chotila	(5000)	2	n.v.	n.v.	0		
Kuchch	Nalliya	Jakhau	(5000)	3	n.v.	n.v.	(5-8)	3 nests, 4-5 males
	Nakhatrana	Gugiliana	n.a.	1	n.v.	n.v.	0	
		Ratipal	n.a.	1	n.v.	n.v.	0	
		Banni	(8000)	3	n.v.	n.v.	0	
Panchmahal	Dohad	Rampura	2700	1	n.v.	n.v.	15-20	

Surveys : 1981 — Goriup and Karpowicz (1985); 1982 - Magrath *et al.* (1982, 1985); 1989 — This study

District	Taluk/ Village	Grassland Name	Grassland area (ha)	Grassland Ownership	No. reported in 1982	No. reported in 1984	No. reported in 1986	No. reported in 1989	Remarks
MADHYA PRADESH									
Ratlam	Sailana	Naulakha	354	1, 2	9	15	12	11	Visit every year
		Hazariya	(90)	2	n.v.	n.v.	4-5	2-3	"
		Nancha bheed	(75)	2	n.v.	(5)	3	1	
		Dhamnod bheed	(300)	2	n.v.	n.v.	2	0	
		Vijay Ramjiki	n.a.	2	n.v.	n.v.	2	n.v.	
		Pallia	(50)	2	n.v.	n.v.	2	n.v.	
		Hamirpada & Tajpuria	(100)	2	n.v. n.v.	n.v.	1	0	
		Badshah ki bheed & Shikarwadi	(150)	2	n.v.	4	6	0	Used to visit; habitat deteriorating
		Beyond Badshah ki bheed	n.a.	2	n.v.	n.v.	2	n.v.	
		Ambha	n.a.	1, 2	n.v.	5	4	2	
		Sheopur	n.a.	1,2	1	n.v.	8	7	Visit every year
	Jaora	Ringnod	n.a.	2	3	n.v.	4	n.v.	
	Kalaliya	n.a.	–	3	(4)	n.v.	4	n.v.	"
		Jhalwa	(200)	–	3	–	n.v.	n.v.	
		Sherpur	–	–	n.v.	(20)	n.v.	n.v.	
		Near Polytechnic	n.a.	2	(2)	n.v.	n.v.	n.v.	
		Agra (Bal kheri)	n.a.		(2)	n.v.	n.v.	n.v.	
Jabhua	Tarkhedi	Thakur Sajjan Singh's land	n.a.	2	5	4	(11)	n.v	4 (9) Visit every year
Dhar	Sardarpur	Chadawat Dhulat, Rajabheda Karnawat, Piparni	n.a.	1,2	9	9	n.v.	7	Series of grasslands used by LF every year
	Sardarpur	Panpura	2700	1	0	0	n.v.	0 (2)	
		17 km from Sardarpur on Ratlam road	(100)	1	n.v.	n.v.	n.v.	2	
	Sardarpur	Gumanpura	2	1	n.v.	n.v.	n.v.		
		Gumanpura Plantation	1	(2)	n.v.	n.v.	n.v.		
		Holataris	2	(2)	n.v.	n.v.	n.v.		

Surveys : 1982 - Yahya (1982, 1990); 1984, 1986 & 1989 This study.

District	Taluk/ Village	Grassland Name	Grassland area (ha)	Grassland Ownership	No. reported 1984	No. reported 1986	Remarks
RAJASTHAN							
Baran	Sangod	Sorson Buld	1000	1,2,3	0	0	1- 2 seen every year
Kota	Mandane	–	(200)	2	n.v.	0	
	n.a.	Railgaon Buld	n.a.	2,3	0	n.v.	
Bhilwara	Shahpura	Shivpura village area	n.a.	2	n.v.	2	All grasslands get LF every monsoon
	Sangamer	Kalsane I	(> 10)	2	7	0	LF Seen in grassland and cropfield
		Kalsane II Bhoom-ka-Bheed	n.a.	2	0	n.v.	LF regularly seen in monsoon
Tonk	Malpura	Dinghara and Rampura area	n.a.	2	n.v.	0	Few birds are seen in cropfields
Ajmer	Sonkhaliya/Kekri/Bagera/ Basu/Tora			1,2,3	n.v	0	Few birds seen every monsoon. Mostly in crop areas
Pali	Omkali	Mostly croplands		1,2,3	n.v.	n.v.	Few birds are seen in monsoon

Surveys : 1984, 1986.

Abbreviations used :
Ownership : 1 = Forest Department, 2 = Private, 3 = Others
n.a. = Data not available, n.v. = Area not visited, LF = Lesser florican
Area in parentheses is approximate. Florican numbers in parentheses reported by others

Appendix 3

1980-1991– RECORDS FROM LITERATURE OR FROM AREAS OTHER THAN THOSE SURVEYED

State	Locatio	Date/Season	Source
Andhra Pradesh	Rollapadu Kurnool dist.	Winter, Summer &Rains; Breeding	Sankaran & Manakadan 1990
Andhra Pradesh	Hyderabad	1 November 1986	Siraj Taher pers. comm.
Andhra Pradesh	Patancheru near Medak	1 November 1984	Siraj Taher pers. comm.
Kerala	Karunagapally, Quilon dist.	14 Jan. 1989	Krishnan 1990
Madhya Pradesh	Near Sehore	Rains/Breeding	P.P. Dhar pers. comm
Madhya Pradesh	Karera Bustard Sanctuary	Jan., June, July, August	Haribal *et al.* 1985
Maharashtra	Nagpur	Jan. 1982	M. Chitampalli pers. comm.
Rajasthan	Pinwada Seroi, Pali dist.	Monsoons/ breeding	F. S. Rathore pers. comm.
Rajasthan	Athun Ganeshpur Nasirabad-Kekri rd Ajmer dist.	1 August 1983/ breeding	Saxena & Meena 1985
Rajasthan	Ajmer dist./ Gagwana, Arain, Mangaliyawas, Ramsar, Goyla, Ratakot & Bandar	Monsoons/ breeding	Saxena & Meena 1985
Uttar Pradesh	Dudwa Tiger Reserve	1981	Tyabji 1982
Uttar Pradesh	Dudwa Tiger Reserve	May/June	Sankaran & Rahmani 1988
Pakistan	Makran, Lasbella	Breeding (1989)	T.J. Roberts pers. comm. 1989
Pakistan	North Lahore near Ravi river	Summer	"
Pakistan	Dadu dist., Sind	September 1988	"
Pakistan	Kasur dist.	Breeding (July 1986)	Roberts 1991
	Sukh Beas river	Breeding (July 1987)	Roberts 1991
Nepal	Shukla Phanta	Summer	B.B. Thapa pers. comm. 1989

Appendix 4

1989 POPULATION ESTIMATE OF THE LESSER FLORICAN

The male lesser florican population in 1982 and 1989 was estimated from the relation:

$P_m = T_a*P_g*Ps*D_m$

where P_m = Male population, T_a = Total breeding range, P_g = Proportion of grasslands in T_a, P_s = Proportion of grassland suitable for lesser florican in total grassland area (P_g), D_m = Density of lesser florican.

1. T_a = Total breeding range

Total area of the present breeding range (actual and possible) of the lesser florican. Area of districts where floricans are/were/could breed (Source: Manorama Year Book 1989).

Gujarat (19 districts)	196084 sq. km
Madhya Pradesh (8 districts)	59222 sq. km
Rajasthan (10 districts)	87218 sq. km
Total	342524 sq. km

2. P_g = Proportion of grassland in T_a

Estimated from data available for 3 districts (Jamnagar, Junaghad and Rajkot) in Gujarat (Magrath *et al.* 1983).

Total area of the 3 districts	35935 sq. km
Mean area for each grassland type (in sq. km):	
Reserved grasslands (173.17 sq. km, n=38)	4.56
Non-reserved grasslands (16.70 sq. km, n=9)	1.86
Private grasslands (25.12 sq. km, n=22)	1.14

Total no. of grasslands present of each category:	
Reserved grasslands	71
Non-reserved grasslands	198
Private grasslands	70 (estimated)

Thus P_g = (4.56*71)+(1.86*198)+(1.14*70)/ 35935

= 0.0215

This was extrapolated over the entire breeding range and a constant grassland area for both 1982 and 1989 was arrived at: 342524 * 0.0215 = 7364.3 sq. km of grasslands within the breeding range.

3. **P_s = Proportion of grassland in P_g** on which male lesser florican were recorded (Magrath *et al.* 1983).

Out of 219.76 sq. km of grassland surveyed in 1982, lesser florican were recorded in 56.92 sq. km.

Thus P_s = 56.92/219.76 = 0.26

This was extrapolated over the entire breeding range and a constant suitable grassland area for both years was arrived at : = 7364.3*0.26 = 1914.72 sq. km

4. **D_m = density of male florican in each year**

1982: 65 males in 56.92 sq. km of grassland = 1.142/sq. km

Thus, in grasslands over entire breeding range = 1.142*1914.72 = 2187 males

1989: 65 males seen/reported in 332.13 sq. km = 0.196/sq. km

Thus, over entire breeding range = 0.196*1914.72 = 375 males

Limitations of the estimate:

a) This estimate is based on the extent of grassland habitat within the breeding range. It has been extrapolated based on data available for 3 districts (Magrath *et al.* 1983). Thus the accuracy of this estimate depends on whether or not data in Magrath *et al.* (1983) is complete.

b) Not all the males in a grassland were seen during the survey. Our estimate assumes that 100% were seen, thus underestimating the population.

c) In 1989 we visited only those well protected grasslands where floricans were known to breed. Our assessment of these grasslands was that they continued to be good breeding habitats. The 1982 survey (Magrath *et al.* 1983) covered optimal, sub-optimal and unsuitable habitats both to assess population and also to study the habitat requirements of the lesser florican (Magrath *et al.* 1985), the latter not being the objective in 1989. While the area of all grasslands surveyed in 1989 has been used to calculate density, only those on which lesser florican were found in 1982 have been used for calculating (i) the proportion of grassland used by floricans and (ii) densities for that year. Disparities arising out of this have not been accounted for.

FORAGING HABITS AND NEST STRUCTURE OF *MACROTERMES ESTHERAE* DESNEUX (ISOPTERA: TERMITIDAE)[1]

K. Sudhakar[2] and G.K. Veeresh[3]

The foraging and nest structure of *Macrotermes estherae* Desneux (Isoptera: Termitidae) in an Agro-Forest ecosystem at the Agricultural Research Station, Chintamani, Karnataka are described. Foraging was observed after dusk on dry leaves and twigs of *Eucalyptus* and dried *Cynodon dactylon* grass. Foraging increased with the onset of monsoon and decreased thereafter. The dome-shaped subterranean nest was built of moist earth at a depth of 60 cm. The tiered chambers had fungus combs in between. The royal cell was situated at the base, below the lowest tier of chambers. There were 11 small and large holes present laterally for the movement of soldiers and workers. The royal cell held physogastric queen, a king, soldiers (major and minor), workers (major and minor) and nymphs.

Introduction

The foraging habits of termites are highly variable in different species. Some termites form earthen tubes with soil and saliva to guard their foraging lines so that the workers are not exposed to their natural enemies like ants. Some use dried fallen leaves as a cover over their forage tunnels. Similarly the time at which foraging is carried out is species specific. The internal structures of termite nests may also vary depending on their foraging habits.

Andrews (1911) made detailed studies on these aspects of *Nasuititermes* sp.; Wood *et al.* (1977) of *Trinervitermes geminatus* Wasman; Roonwal (1970) of *T. biformis,* and Nutting (1970) of *Teneurostritermes tenurostris.*

Macrotermes estherae Desneux is prevalent in Karnataka state and very little is known about its foraging habits and nest. Bugnion (1915) and Roonwal (1970) reported that the workers and soldiers of *M. estherae* march in columns under leaves. Roonwal (1970) reported that the nest of *M. estherae* is subterranean and that they build no mounds but for small earthen hillocks of about 2 to 8 cm height. It was also reported that the nest consists of galleries and chambers. However, detailed information on foraging, internal architecture of the nest, fungus combs, royal cell etc., are wanting. Hence a detailed study on the above aspects was made and the information obtained is presented in this paper.

Material and Methods

The study was undertaken in a locality where cultivated and forest areas were present side by side. During the years 1979-1983 observations were recorded at the Agricultural Research Station, Chintamani (University of Agricultural Sciences, Bangalore) which is situated adjacent to a forest. The termite specimens were collected and preserved in 70% alcohol, and were indentified by the Zoological Survey of India, Calcutta, as *M. estherae.*

Frequent and general observations were made in the field at dusk, dawn, day and night on the foraging habits. Night investigations were carried out using torch lights. In addition, wood and dung pieces as baits were placed about 20 m apart along the field bunds in the cultivated field and forest area, and weekly observations were carried out from February 1981 to December 1982 on the termites attracted to the baits. The area of foraging activity was demarcated, measured and assessed based on the spread of the foraging holes and the source of food.

To study the character of the nest and its contents, the points of probable location of nest

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underground were identified by the presence of small earthen lumps of soil of large sized particles compared to of *Odontotermes* and *Microtermes*, each weighing about 3 to 6 kg. The pits were dug out very carefully with the help of crowbar and spade to reach the nest.

Results and Discussion

Foraging habit: The workers of *M. estherae* come out of small holes of 0.8 cm diameter and move in columns to the source of food. The columns of workers are not covered with any earthen sheathing unlike in other species such as *Odontotermes obesus*. They forage on dry fallen leaves, twigs of *Eucalyptus*, dry blades of *Cynodon dactylon* and dried bits of a bushy plant, *Canthium parviflora*. It was observed that they rarely fed on dung pads spread in the field, while wooden pieces were not fed upon. They actively foraged during the night, and occasionally in the cool hours of early morning or late evening. This is probably because of the non-sheathing (tube formation) habit of the species. Foraging activity was absent or very low when there was fall of dew at night accompanied by low temperature. Foraging activities increased with the onset of monsoon and decreased by November-December with the cessation of rains and the onset of humid winter weather.

Foraging groups consisted of soldiers (major and minor) and workers (major and minor) that went out in columns of single or double rows. The major soldiers guard near the foraging hole from inside while the minor soldiers accompanied the workers, guarding them. Roonwal (1970) reported that workers and soldiers of *M. estherae* go out for foraging in a column under the leaves, but in the present study it was observed that the termites moved openly without the cover of leaves. The foraging holes were distributed on the surface to about 20 m away from the nest. Subterranean galleries connect the foraging holes with the nest. The foraging holes were covered with small conical solid earthen caps of 4 to 5 cm height. This is very typical of this species.

As and when the forage group comes out, a hole is made in this structure for the exit of workers. Roonwal (1970) has reported on the presence of subterranean galleries as well as on the small earthen hillocks of about 2-8 cm height. In a one square metre area 4-5 forage holes were noticed from which the workers moved out and foraged in a radius of one metre. Workers and soldiers climbed on to the plant, cut the leaves and bark and worked on the material to break it to pieces. The food material was carried by individual workers or by groups and 2-3 cm long pieces were taken into the foraging holes.

Soldiers helped workers in peeling out bark by beating with their head and mandibles. The soldiers were so sensitive that even minor disturbances triggered them to respond by making a rustling sound by beating their heads on the substratum, where upon workers moved, leaving the food material to quickly re-enter the holes. In such emergencies soldiers were the last to enter, allowing other members first. When all the members had entered, workers closed the holes with moistened soil particles, brought from inside. Once the holes were closed, they were not opened to admit termites that arrived late, and tapped at the closed entrance from outside. Those that remained outside were eventually picked up by predatory ants. Similar observations of foraging was recorded on the open forager, *Tenurostritermes tenuirostris* in Southern Arizona by Nutting (1970).

Nest structure: There are no detailed reports available on the structure of the underground nest of *M. estherae* royal cell and fungus comb. However, Roonwal (1970) has reported that the nest consists of a system of communicating galleries and chambers made in almost dry soil, running horizontally in different directions for a distance of about 100 m or more.

It was observed in the present study that by November-December soil mounds of larger par-

ticle size weighing about 3-6 kg were formed on the ground surface. These mounds were formed by the excavated soil carried out by the workers while making the nest with tunnels and chambers to accommodate royal cell and fungus combs. In this excavated soil a central tunnel leads to the nest but the external opening of the tunnel remains closed. The excavated earth mixed with saliva becomes hard, forming the mound. The mound had the following physico-chemical composition:

Coarse sand 29.50%, Fine sand 42.50%, Silt 4.2%, Clay 19.5%, pH 5.4%, Organic carbon 0.24%, Total Nitrogen 0.03%, Available average P_2O_5 5.08 ppm, Available K_2O 4.10 ppm.

Such mounds gave an indication of the presence of the nest of *M. estherae* underground. When the mound was removed and soil excavated, the nest was found at a depth of 60 cm. The underground nest was 24-25 cm in diameter. It was dome-shaped, soft and brittle like a newly made mud pot which easily breaks at the slightest touch, but soon became hard when exposed to outside atmosphere. The vertical section of the nest indicated that there are three tiers of chambers around a central vertical pillar-like column of leftover earth. The royal cell is situated at the bottom of the nest below the lowest tier of chambers. These chambers and communicating galleries of different tiers are further interconnected with galleries for the movement of workers and soldiers.

Royal cell: The royal cell was made of fine soil with smooth walls with occasional small depressions. The roof was hemispherical in shape. The cell had a circumference of 32 cm, diameter of 11 cm and a height of 1.6 to 1.7 cm. Laterally there were small holes of 0.3 to 0.4 cm diameter each and larger holes of 0.5 to 0.6 cm for the movement of workers, soldiers (minor and major) and nymphs. The larger holes were used by the major soldiers. In all there were 10 to 11 holes.

Inmates of the royal cell: The royal cell held a physogastric queen, a king by the side of the queen, soldiers (major and minor), workers (major and minor), and nymphs. Eggs were not seen in the royal cell at the time of observation.

Castes in Royal Cell:

Queen: 3-5 cm long, 0.8 cm broad at the abdomen, dark brown with pale intersegmental membrane. *King:* One centimetre long and dark brown. *Nymphs:* Pale white, around the queen close to the sides of the body, especially abdomen. More nymphs than workers or soldiers were present in the royal cell. *Soldiers:* Next to nymphs the major soldiers were most numerous in the royal cell. They were seen surrounding the queen in a characteristic defensive position, with heads towards the periphery of the cell. Some soldiers blocked the holes of the royal cell with their heads. Some minor soldiers were observed carrying nymphs. Workers moved in and around the royal cell. *Fungus combs:* In the chambers of the tiers of the nest. Ear-shaped fungus combs were found inserted loosely. They were 9 cm long and 4.5 cm broad, greyish white with black and shaped like a human ear on the broader side; this is peculiar to this species. White spherical masses of conidia were present on the fungus combs. Roonwal (1970), however, reported that fungus combs in *M. estherae* were small and about 5 cm in diameter, with cavities having convolutions like those in the human ear.

Chemical analysis revealed that the fungus comb contained 0.36% nitrogen, 0.04% phosphorus, and 0.06% potassium. Wood and Sands (1978) reported 0.68, 0.07 and 0.10% of nitrogen, phosphorus and potassium respectively in old fungus combs of *M. bellicosus* (Snethman).

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SOME ADDITIONS TO THE ORCHID FLORA OF ORISSA[1]

O.P. Misra[2], D.C.S. Raju[3] and S.C. Misra[4]

Introduction

Attempts were made during the last ten years to study the native orchids of Orissa. Several field trips to the forest tracts of Koraput, Kalahandi, Mayurbhanj and Sundergarh districts were made and collections of both terrestrial and epiphytic orchids obtained which were cultivated to observe the flowers wherever necessary. As many as 80 species have been collected so far, and these include all the species listed by Panigrahi and Raju (1964), Kapoor (1964), and the orchids already described by Haines (1925) from Bihar. Some new localities were found for the orchids hitherto known only from Sikkim Himalaya and Western Ghats. Brief notes on taxonomy, distribution and ecological aspects of six epiphytic orchids are given in this paper.

Dendrobium cathcartii Hook.f. in Fl. Brit. Ind. 5: 727, 1890. King et Pantling in Ann. R. Bot. Gard. Cal.8; t. 57, 1898.

Epiphytes with many slender, erect stems 30-50 cm tall. Leaves many, linear-lanceolate, obliquely notched at the apex, 10-15 cm long and 1.2 cm wide. Flowers in fascicles of two from internodes, small, golden yellow pedicels slender, up to 1-5 cm long. Sepals lanceolate except dorsal one; petals much narrower, elliptic oblong, marked purple, column short.

Flowering: May.

Distribution: Sikkim Himalayas up to 1200 m

Orissa: Mayurbhanj district, Simlipal Hills. *S.C. Misra* 72 (CAL).

This is the first record of the plant outside the type locality in Sikkim. The species seems to prefer humid tropical climate and occurrence of the plant on Meghasihi indicates the possible distribution of the species in the Eastern Ghats.

D. cathcartii Hook.f. can be easily identified from *Dendrobiums* in Orissa by the slender shoots bearing bamboo- or palm-like leaves and small yellow flowers in fascicles on internodes.

Dendrobium pequanum Lindl. in Jour. Linn. Soc. 3: 19, 1859; *D. pygmaeum* Lindl. Gen. Sp. Orch. 85, 1830 (non Smith ex Rees 1808): King and Pantling in Ann. R. bot. gard. Cal. 8: 43, t. 58, 1898. Haines, Bot. Bihar & Orissa, 1173, 1925. Sant. & Kapadia, Orchids of Bombay 84, 1966.

A very small epiphytic orchid with short (1 cm) ovoid pseudobulbs covered with membranous sheath and leafless at the time of flowering. Flowers white, in 2-3 short racemes borne at the apical part of pseudobulbs. Sepals pale green, oblong-lanceolate, laterals decumbent; petals white; lip pale green, midlobe suffused with purple, crisped. Leaves two, terminal, caducous, linear oblong, up to 6-7 cm x 1.4 cm.

Flowering: October.

Distribution: Sikkim Himalaya, Jaspur in Bihar, Burma; on Western Ghats in Konkan and N. Kanara.

Orissa: Sundergarh district, Koira forest, Koraput district, Mattili forest. *S.C. Misra* 30 (CAL).

This small orchid inhabits branches of trees under high rainfall conditions and as such is rarely collected in India. A flowering specimen was put in cultivation by D.C.S. Raju at Calcutta and leaves were observed.

Bulbophyllum careyanum (Hook.) Spreng. Syst. Veg. 3: 732, 1826; Hook.f., Fl. Brit. Ind. 5: 760, 1890, King and Pantling in Ann. R. bot. Gard. Cal. 8: 71, t. 97, 1898; Seidenf. & Smitin. Orch. Thailand 428, t. 321, 1961.

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Anisopetalum careyanum Hooker, Exotic Flora t. 149, 1825.

Epiphytes with thick rhizomes bearing ovoid pseudobulbs at intervals. Leaves solitary, elliptic-lanceolate, 15-20 x 2.5-5 cm. Scape bearing a short cylindrical raceme which is decurved. Flowers dark brown, many, small, subtended by lanceolate bracts. Sepals unequal, dorsal one small (0.7 x 0.3 cm), laterals ovate, cohering by their tips. Pedicels 3-4 mm. Petals orange yellow, much smaller than sepals, narrowly triangular. Lip longer than petal, oblong, with two falcate lateral lobes, minutely ciliate; column with two lateral teeth and curved foot.

Flowering: October-December.

Distribution: Nepal (type locality), Sikkim Bhutan, Burma, Thailand.

Orissa: Sundergarh District, Chunaghat (1800 m). *S.C. Misra* 39 (CAL)

This is the first record of the species from Chhotanagpur plateau. The occurrence of this plant in Orissa is correlated with the pattern of tropical monsoon climate prevailing in Thailand, Burma and north Himalaya with high rainfall ranging from 150-300 cm per year.

Sarcochilus luniferus (Reichb. f.) Hook.f. in Bot. Mag. t. 7044, 1889 et Fl. Brit. Ind. 6: 37, 1890; King and Pantling in Ann. R. Bot. Gard. Cal. 8: 207, 1898. *Thrixisperumum luniferum* Reichb.f. in Gard. Chr. 786, 1868. *Chilochista lunifera* J.J.Sm., Fl. Buitenz. 6: 553, 1905. Sant. & Kapad. Orch. Bombay 209, 1966.

Small epiphytes with thick green roots. Stem very minute, bearing two small linear lanceolate leaves, 2.5 x 0.5 cm, narrowed at base, acute at apex. Scape up to 10 cm long, thickening upwards, pubescent, bearing 4-6 flowers in a lax raceme. Flowers small, mustard brown, 1.3 cm in diameter, almost sessile; sepals and petals dull yellow, spotted with mustard brown. Lip inflexed, lateral lobes curving upwards and inwards, has a pouch like a baby-shoe at the base of middle lobe, column very short.

Flowering: June, but much earlier under cultivation.

Distribution: Sikkim, N. Kanara, Burma and Java.

Orissa: Sundergarh district, in Koira forest. *S.C. Misra* 43 (CAL).

This is the first record of the plant from Chhotanagpur plateau and indicates the continuous distribution of the species in monsoon forests of south-east Asia.

Santapau and Kapadia follow J.J. Smith (1905) in treating this species under *Chilochista,* a genus erected on the basis of leaflessness. Parish observed leafy condition in *S. luniferus* cultivated at Kew and we confirm his statement from observations on the plant from Orissa. We follow Schlechter (Di-Orchid 533, 1927) Hook.f. (l.c.) and Holttum (1953) in maintaining *Sarcochilus* R.Br.

Acampe ochracea (Lindl.) Ochr. in Bull. N.V. Bot. Gard. 6: 270, 1910. *Saccolabium ochraceum* Lindl. in Bot. Reg. Misc. 2, 1842; Hook.f., Fl. Brit. Ind. 5: 62, 1890.

Epiphytes with erect or pendulous stems. Leaves coriaceous, many, oblong, 15 x 2 cm, sheathed at base, unequally lobed at apex. Inflorescence 20 cm long, panicles lax, branching. Flowers yellow, pedicelled and bracteate. Sepals and petals similar, 2.5 mm long, obovate, yellow with reddish transverse marking; lip small, 3-lobed, pinkish; capsule up to 3 cm long. Spur oblong, parallel to the ovary; column short, with two lateral horns.

Flowering: December.

Distribution: Sikkim Himalaya, Meghalaya, Burma, Sri Lanka and Western Ghats.

Orissa: Mayurbhanj district. *S.C. Misra* 67 (CAL).

This plant seems to be well adapted to monsoonal climate (areas with precipitation of 200 cm and above). Absence of suitable ecological niches in Coromandel coast is probably the reason for its discontinuous distribution in the Eastern Ghats. This species can be distinguished in the field from *A. praemorsa* by the lax panicles and unequally lobed leaf apex.

Cottonia peduncularis (Lindl.) Reichb.f. in Cat. Orchid. Schiller 52, 1857; Hook.f., Fl. Brit. Ind. 6: 26, 1896. *Vanda peduncularis* Lindl. Gen. Sp. Orch. 216, 1833. *Cottonia macrostachys* Wight, Icon. 5(1) 21, t. 1755, 1851.

Epiphytic orchid with erect cylindrical stem, and many aerial roots. Leaves several, oblong, recurved, sheathing at base, apex with two unequal rounded lobes. Inflorescence quite long, up to 75 cm, branched, flowers very few in a raceme at apex of peduncle branches, bracteate, pedicellate, usually opening one at a time. Pedicel 2 cm long, sepals and petals recurved backwards, obovate oblong, 8 mm, light yellow with longitudinal purple lines. Lip very conspicuous, resembling a bee sitting on flower, 1 cm long, purple with golden yellow villous margin. Column without foot, with two short projections forming a ledge. Capsule fusiform, 5-6 cm long.

Flowering: March-May.

Distribution: Western Ghats (India) and Sri Lanka.

Orissa: Koraput district, Mohulbhatta forest near Jeypur. *S.C. Misra* 16 (CAL).

This interesting orchid is so far only recorded from Western Ghats in parts of Maharashtra, Karnataka, and Kerala. Its occurrence in the Eastern Ghats of Orissa indicates the availability of humid tropical condition to which this species is adapted.

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COMPARATIVE ECOLOGY OF THE CAPPED LANGUR *PRESBYTIS PILEATA* BLYTH IN TWO FOREST TYPES IN BANGLADESH[1]

CRAIG B. STANFORD[2]

(With three text-figures)

The ecology of the capped langur *Presbytis pileata* in moist deciduous and wet semi-evergreen forests in Bangladesh are compared. In moist deciduous *Shorea robusta* forest, capped langurs occupy smaller home ranges, travel shorter distances each day, and occur at higher population density than in semi evergreen forest. The species is more highly folivorous in moist deciduous forest than it is when sympatric with *Presbytis phayrei* and other primate species in wet semi-evergreen forest. A breakdown of the diet of the species in each habitat is presented, and the results are discussed in terms of seasonal food availability influences on group size and ranging patterns.

INTRODUCTION

A number of investigators have observed that the ecology of a given species of non-human primate may vary greatly depending on the type of environment in which it is studied. The effect of such habitat variation on group size, structure and behaviour is an area of much interest in the formation of ideas about the importance of different influences on primate social organisation. Some primate species, such as Hanuman langurs *Presbytis entellus*, exhibit striking variability in social organisation with an unclear relationship to habitat type (Vogel 1973, Mohnot 1971), while other species (gibbons, for example) are relatively invariant in social organisation across a wide spectrum of environments.

The capped langur *Presbytis pileata* Blyth 1843, is a colobine monkey inhabiting the eastern portion of the Indian subcontinent. *P. pileata*'s geographic range is western Burma, the north-eastern states of India and central and eastern Bangladesh. Pocock (1928, 1939) reports *Presbytis pileata* in the eastern Bay of Bengal region in Assam and Burma, but both he and Fooden (1971) state *P. pileata* and another colobine, *P. phayrei*, to be strictly allopatric in this region. More recent surveys in the area by Reza Khan and Ahsan (1986) and Gittins and Akonda (1982) revealed a narrow zone of sympatry in the easternmost portion of the country. Across this relatively small area, *P. pileata* varies greatly in pelage colouration. The subspecies *P. pileata durga* of central and northern Bangladesh has a flame orange venter and lateral facial tufts, and a slate grey dorsum, limbs and tail. Previous surveys have documented the presence and status of a rich primate fauna (Green 1978, Gittins and Akonda 1982, Reza Khan and Ahsan 1981), but few long-term data are available on any species. Islam and Hussein (1982) and Green (1981) had conducted short-term field studies on capped langur ecology before the present field study was undertaken.

The capped langur lives mainly in one-male groups. It is an almost totally arboreal species, coming to the ground only to drink from hollow tree stumps and to cross forest clearings. A typical capped langur group at Madhupur is composed of one adult male, four adult females plus immatures. Newborn infants have a pale orange natal coat colour, darkening to apricot orange before turning to the adult orange and grey by about three months.

This paper reports the results of a field study of the ecology and behaviour of this little-known monkey in reserve forest areas in north-

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central and north-eastern Bangladesh, encompassing two quite different forest types.

Methods

The main study site was Madhupur National Park in north-central Bangladesh (Fig. 1). Madhupur is moist deciduous forest dominated by sal *Shorea robusta* and is comprised of approximately 149 tree species (Salar Khan, pers. comm.). Madhupur 24°30′ N, 90°10′ E) was once part of an extensive area of deciduous forest of the central plain of Bangladesh. The area stands at an elevation never more than 15 m above sea level, and average annual rainfall is 220 cm. The region consists of flat ridges running north-south which are bisected by long narrow depressions (baids), swamp forests which have been largely given over to rice cultivation. Today the forest tract is broken into blocks of varying sizes. The national park lies at the north-western corner of the region and has an area of approximately 100 sq. km. The northern section of the park has been almost completely cultivated by the local Garo tribal population; the predominant cash crop in this area is pineapple. The southern portion of the park, approximately 40 sq. km, formed the study area. This area includes several settlements and patches of scrub forest but is still predominantly sal forest and is in good condition. Most of the trees are approximately 15 m in height with emergents, especially *Albizzia* ssp., reaching 25 m. Predominant tree species at Madhupur are *Shorea robusta* (Dipterocarpaceae), *Adina cordifolia* (Rubiaceae), *Dillenia pentagyna* (Dilleniaceae), *Lagerstroemia flos-reginae* and *Garruga pinnata* (Burseraceae). Although hunting of primates and other large mammals occurs in some forest regions of Bangladesh, the Garo at Madhupur do not hunt or eat langurs. Rhesus macaques *Macaca mulatta* are abundant in the park and occasionally raid rice crops, leading to human harassment.

Approximately 1400 hours were spent in contact with groups of *Presbytis pileata* in this forest type, most of which were 10 minute scan samples collected at Madhupur National Park. At this site *P. pileata* is sympatric with rhesus macaque. Groups were located at sunrise and followed throughout the day to obtain data on home range and day range. Five study groups were followed on a regular basis, and most of the observations were made on one group of 13 animals that consisted of one adult male, five adult females and immatures. Plant species eaten and common species that were avoided were collected and identified with the help of the Forest Department. At Madhupur the phenological cycles of 338 trees in a 1.2 ha transect were monitored and the results are presented elsewhere (Stanford 1989). Data on diet were collected by recording the plant part, and when known, the plant species on which an animal fed. Ranging data is based on a grid superimposed over a map of the study site; the entire study site was divided into 0.1 ha quadrats and trees were marked, so at any time I could determine my approximate location. Compiling the map quadrats into which the langur troops travelled over the course of the study enabled me to establish home range and mean day range.

The other forests in which *Presbytis pileata* was observed were Rajkandi and Kalenga Reserve Forests in Sylhet district, near the border with the Indian state of Tripura (24°15′ N, 91°55′ E). Surveys were made in October 1986, April 1988 and November 1988. Approximately 110 total hours were spent in contact with *P. pileata* and *P. phayrei* groups in the reserve forests there. Thus the results presented here are based primarily on Madhupur with briefer comparative observations in Sylhet. Rajkandi is a wet semi-evergreen/bamboo forest habitat (Puri 1960) located in the wet zone of the Eastern Bay of Bengal region, receiving up to 750 cm of precipitation per year. Predominant tree species in these forests are *Dipterocarpus* spp. (Dipterocarpaceae), *Terminalia bellerica* (Combretaceae), and *Sterculia villosa* (Sterculiaceae). At Rajkandi at least five species of nonhuman

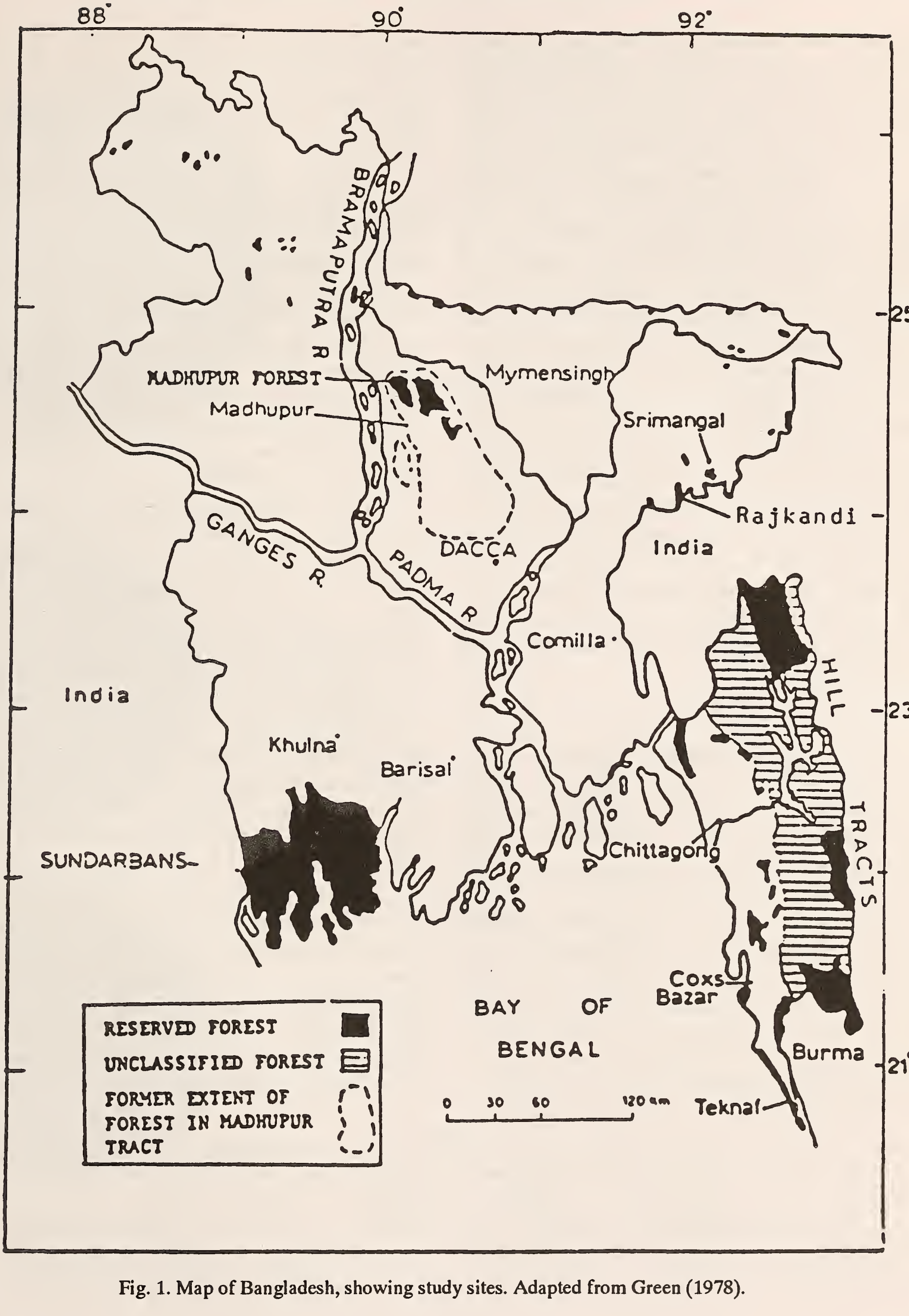

Fig. 1. Map of Bangladesh, showing study sites. Adapted from Green (1978).

primate are sympatric: hoolock gibbon *Hylobates hoolock*, rhesus macaque, pig-tailed macaque *M. nemestrina*, Phayre's leaf-monkey *Presbytis phayrei* and capped langurs. In addition to these species observed in this forest, Gittins and Akonda (1982) reported Assamese macaque *M. assamensis* and slow loris *Nycticebus coucang*. Remaining natural forest in this northeastern region has been reduced to isolated forest blocks of from 10-70 sq. km; Rajkandi is a tract of approximately 40 sq. km, and is a tract of primary forest surrounded by plantation teak and secondary forest. Kalenga Forest contains only remnants of natural forest interspersed with teak, sal and mahogany plantations.

At Kalenga and Rajkandi, data were collected on diet and feeding ecology of both *Presbytis pileata* and *P. phayrei*. *Presbytis phayrei* was reported to be highly folivorous in similar wet semi-evergreen forest in north-east India (Mukherjee 1982); this suggested a dietary shift by *P. pileata* when sympatric with *P. phayrei*, an assumption I tested using the data from the present study.

Results

The ecology of *Presbytis pileata* differed markedly in the two habitat types. In moist deciduous forest the animals occurred in smaller groups, ranged less widely and occurred at significantly higher density than they did in wet semi-evergreen forests (Table 1).

The results of the transect analysis of vegetation showed that mature leaves were the most abundant and reliable food source for Madhupur capped langurs. During the winter months, when a synchronous leaf fall occurred, enough tree species retained their leaves to sustain *P. pileata* on a diet that consisted largely of mature leaves during these months. During the summer monsoon, when both mature leaves and ripe fruit were available, the animals fed heavily (50% of all feeding records from May through September) on fruit.

Mature leaves comprised the majority of annual feeding records in both moist deciduous and wet semi-evergreen forest (Fig. 2), though when sympatric with *P. phayrei* the latter species is more folivorous (Fig. 3). Populations of *P. pileata* are more highly folivorous in moist deciduous forest than in the wetter semi-evergreen forest. At Madhupur, capped langurs subsisted on mature leaves (42.0%), but switched to fruit (24.4%) and young leaves (10.9%) whenever these were available (n = 20,460 feeding records).

In semi-evergreen forests *P. pileata* concentrated more heavily on fruit and fed to a lesser extent on mature foliage (Fig. 3; mature leaves = 23.3%, fruit = 54.4%, young leaves = 4.3%, n = 890 feeding records). The density of the forest at Rajkandi and the lack of habituation of the animals prevented detailed behavioural observation, but day range for *P. pileata* was significantly greater in semi-evergreen forest than in moist deciduous forest. One *P. phayrei* group travelled approximately 485 m/day (N = 4 days), and home range for *P. phayrei* groups was approximately 32 ha during the brief periods of observation.

Presbytis pileata occurred in larger groups in sal forest than in wet semi-evergreen forest. In moist deciduous forest all *P. pileata* groups were one-male (n = 50 groups), and there were a small number of all-male bands and lone males. Groups were also one-male in semi-evergreen forest, but contained a larger mean number of adult females (Table 1).

Table 1
COMPARATIVE ECOLOGY OF *Presbytis pileata* IN TWO HABITATS

Forest type	Hours of observation	Population density	Number of groups	Group size	Group sex ratio	Mean day range (m)
Moist deciduous	1400	53/sq. km.	50	8.5	0.20	325 (n=70)
Wet semi-evergreen	110	13/sq. km.	11	10.6	0.17	485 (n=4)

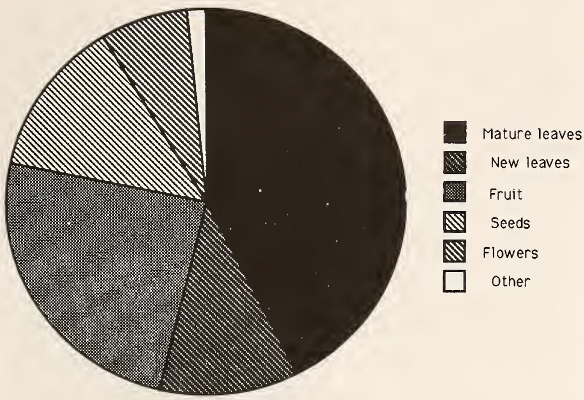

Fig. 2. Diet of *Presbytis pileata* in deciduous sal forest at Madhupur.

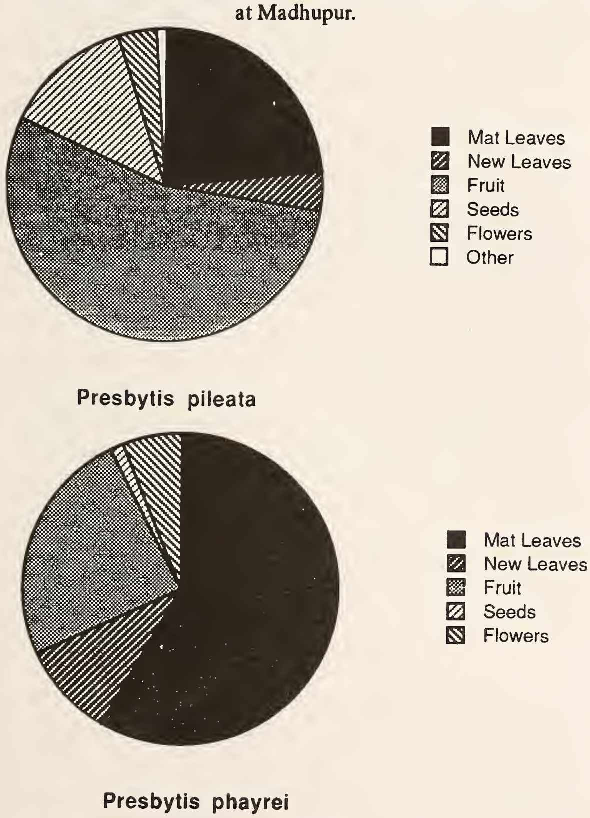

Fig. 3. Diets of *Presbytis pileata* and *P. phayrei* in sympatry.

Comparison of intergroup relations: The relationship between one-male groups occupying the same area of forest also differed between the two forest types. In Madhupur, groups had widely overlapping home ranges and encountered each other approximately once per day. Neither territorial border nor food trees were defended, and the relationship among groups that encountered each other regularly was relaxed, with little overt aggression. Three or four one-male groups were often observed in adjacent sleeping trees or feeding in the same large *Ficus* spp. tree crown. Encounters with unfamiliar groups or extra-group males, by contrast, were hostile and involved much mutual chasing by the resident and intruding males (Stanford 1989).

Although the smaller amount of time spent in wet semi-evergreen forest limits what can be said about capped langur behaviour there, conspecific groups appeared to actively avoid each other more often, in addition to travelling faster and farther each day. At Rajkandi groups of *P. pileata* and *P. phayrei* were observed to feed in the same or adjacent trees. No direct interaction was observed between the groups and there appeared to be no actual mixing of individuals of the two species. *Macaca nemestrina* occurs at very low density in this forest (Stanford, pers. observ., Gittins and Akonda 1982) and *M. mulatta* is common. *Hylobates hoolock* has been recorded to occur at Rajkandi in densities of 0.4 groups/sq. km (Khan and Ahsan 1981) and is a potential competitor for plant foods, but only incidental observations were made of this species during the course of the study.

Discussion

Because vegetation sampling and identification were limited to the moist deciduous forest type, no quantitative analyses of the influences of food distribution and abundance on ranging and feeding can be made for the wet semi-evergreen forest populations. Thus if there were differences in the seasonality of food dis-

tribution, these cannot be related to differences in ranging or feeding between the two sites because of the lack of comparable data from the wet semi-evergreen forest. In spite of this, some assessments can be made of the effect of the differences in habitat on the ecology of *Presbytis pileata* when it is sympatric with another leaf-monkey and when it is isolated in highly seasonal forest. For langurs in a moist deciduous forest, food is severely limited in the dry winter season, as at Madhupur when approximately 70% of all trees in the study sites were bare of foliage. During this season the animals eat mature leaves on the trees that remain in leaf, and supplement this diet with figs (*Ficus bengalensis*) that are available in late winter. That the langurs in moist deciduous forest suffer some nutritional deficit is suggested by the nearly total decline in frequency of social play during the winter months (Stanford 1989). The winter season in the wetter forests of Sylhet is less pronounced, though the seasonality of rainfall and temperature is quite marked.

The other factor that may account for the differences noted between the species in two different habitats is the feeding ecology of sympatric primate species. At Madhupur capped langurs are sympatric with only one other primate, rhesus macaques — both species were seen feeding in the large crown of fruiting *Ficus* spp. in the winter season. In semi-evergreen forest, capped langurs must share their resource base with two macaque species, plus *Presbytis phayrei* and hoolock gibbon. At other sites where the feeding ecology of sympatric leaf-monkeys have been studied (*P. entellus* and *P. senex* in Sri Lanka, Hladik 1977; *P. obscura* and *P. melalophos* in Malaysia, Curtin 1976), some niche separation has been noted with respect to the proportion of leaves and fruit in the diet. At Polonarruwa in Sri Lanka, for example, *P. senex* is more highly folivorous than is *P. entellus*, though where *P. senex* occurs in isolation (Horton Plains, Rudran 1973) it is less highly folivorous, quite similar to the pattern of ecological divergence in allopatry and sympatry observed for *P. pileata*.

The observed difference in group size was initially hypothesized to be due to the greater diversity of predators in the semi-evergreen forests. Recent researchers have hypothesized that predation risk is a major factor influencing primate sociality and suggest that group size tends to be larger where predation risk is greatest (van Schaik 1983). Leopards *Panthera pardus* and a rich array of raptorial birds occur at Rajkandi as possible predators on primates. Leopards have been considered rare in the Madhupur region for the past 15 years, but jackals *Canis aureus* are abundant and were observed to hunt both adult and immature capped langurs during brief ground forays by the monkeys (Stanford 1989). Both crested serpent eagle *Spilornis cheela* and black eagle *Ictinaetus malayensis* are common and are potential predators of young langurs. During 15 months of observation at Madhupur, two predation events were observed involving cooperatively hunting jackals. It seems unlikely, therefore, that a lack of predation in moist deciduous forest could account for smaller group sizes.

There are thus two plausible explanations for the differences in the capped langur diet observed at the two sites, the first caused by the different pattern of food distribution and availability, and the second, by differing degrees of competition for food with sympatric arboreal herbivores. A long-term study of *Presbytis pileata* in the wet forest regions of Rajkandi or Kalenga that includes a detailed vegetation analysis and data collection on the other primates is required to sort out the factors involved.

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PROLONGED EGG INCUBATION AND CONGENITAL TAIL DEFORMITIES IN *CROCODYLUS PALUSTRIS* (REPTILIA: CROCODILIA)[1]

L. A. K. Singh[2] and S. R. Sagar[3]

(With a text-figure)

Introduction

The temperature and moisture available to reptilian eggs during incubation play an important role in the proper development of the embryo. Lynn and Ullrich (1950) have demonstrated that gross morphological abnormalities in developing chelonian embryos may appear due to deficiency of moisture during incubation of eggs. High temperature during incubation of eggs was thought to have caused tail deformities in the gecko *Oedura ocellata* (30°C) and the New Guinea freshwater crocodile *Crocodylus novaguineae* (38°C) (Bustard 1969). Kar and Bustard (1982) attributed tail deformities in *Crocodylus porosus* to desiccation of eggs during incubation. Singh and Bustard (1982) obtained 11 (2.3%) instances of 'bent-tails' out of 476 eggs of *Gavialis gangeticus.* They presumed that the defect "could be the result of desiccation", which "if present, was present during only the last four weeks of incubation". Singh and Bustard (1982) also recorded "at least" 200 hatchlings which had non-persistent curled-up tail tips.

In this paper an account is given of the congenital tail deformities in the mugger crocodile *Crocodylus palustris.* The nests recorded prolonged incubation periods apparently caused by higher incidence of rainy days with hailstorms and severe daily fluctuations in temperature and humidity. The relationship between incubation period, unabsorbed residual yolk and post hatching care to young are also discussed.

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Material and Methods

At the Mugger Research and Conservation Unit (MRCU) in Ramatirtha, Orissa, four females, serially numbered 1.2, 1.6, 1.9 and 1.4 according to their body length, were used for captive breeding in the year 1990. Females 1.2 and 1.6 nested on 13 March and the others on 21 March. The nest of female 1.2 received partial shade from the adjacent trees. The nests of females 1.6 and 1.9 were near a banana clump while the nest of female 1.4 was provided with a thatch shade. The shade for the 1.4 nest was made to incubate a nest at lower temperatures so that the net result of 1990 breeding would produce a mixture of hatchlings from both sexes.

Continuous summer rains were experienced that year while the eggs were incubating *in situ* (Table 1). The week-old eggs were not shifted after the first shower, or later, for fear of causing greater damage by disturbing the embryo and the micro-environment of the nest. Moreover, there was a persisting hope that the rain would not last. Waterlogging did not take place because of the large sand banks used for nesting.

The mean ambient temperature ranged between 17.0 ± 2.2°C minimum and 33.1 ± 4.2°C maximum (Table 1). The nest temperatures measured at 44-days incubation were 26°C (nest no. 1.4), 29°C (nest nos. 1.6 and 1.9) and 32°C (nest no. 1.2). Wide fluctuations in the nest temperatures were, however, expected on the days of rain as rain with hailstones was a regular feature after very warm hours of the day. On the 44th and 63rd days of incubation the nest moistures were 12-13% by weight except in nest no. 1.4 where it was approximately 15%.

After 63 days incubation *in situ* the eggs

TABLE 1
METEOROLOGICAL DATA RECORDED AT MRCU, RAMATIRTHA DURING THE INCUBATION PERIOD OF *C. palustris* EGGS IN 1990

	March (13-31)	April	May	June	July (1-16)
Ambient Temperature °C					
Minimum					
Mean ± S.D.	17.0 ± 2.2	20.4 ± 3.6	22.1 ± 2.6	22.7 ± 2.1	22.4 ± 0.7
Range	15-23	15-25	15-25	15-25	22-24.5
Maximum					
Mean ± S.D.	29.6 ± 2.5	33.1 ± 4.2	33.0 ± 1.5	30.5 ± 2.6	26.8± 1.6
Range	25-34	24-40	30-36	24-34	24-29
Rainfall					
No. of days	6	9	12	23	13
Quantity (mm)	19	41	109	434	266
Relative Humidity at 1200 hrs. (%)					
Mean ± S.D.	66.1 ± 4.1	64.0 ± 3.8	70.2 ± 2.5	76.2 ± 3.6	77.7 ± 1.5
Range	61-75	60-76	64-75	70-86	76-82

TABLE 2
Crocodylus palustris: RESULTS OF EGG INCUBATION DURING 1990 AT MRCU, RAMATIRTHA

Female no.	1.2	1.6	1.9	1.4
No. of eggs	36	27	36	28
No. of hatchlings:				
On day-1	31 (86.1%)	12 (44.4%)	18 (50.0%)	19 (67.8%)
On day-7	31 (86.1%)	12 (44.4%)	15 (41.6%)	9 (32.1%)
Durations (days) of:				
Incubation	77	86	94	117
Post-hatching care	7	9	15	36
Treatment received by the nest:*				
	Partial shade from adjacent trees	Shade and moisture because of banana clumps near nest		Sloped thatch shade at a height 0.35-1.4 m.

*Eggs shifted to hatchery after 63 days.

were shifted to a hatchery protected from rain and having an incubation medium kept at 30-31°C and 7-10% moisture by weight.

RESULTS

On the 63rd day when eggs were shifted from the breeding pen to the hatchery, the eggs of nest no. 1.4 had distinct white bands on the shell. The bands ranged between 2.5-4.0 cm wide, corresponding to a developmental age of only 7-30 days of *Alligator mississippiensis* (Ferguson and Joanen 1982) and 7-40 days of *Crocodylus porosus* and *Crocodylus johnstoni* (Webb *et al.* 1987).

The incubation period for the nest no. 1.4 was 117 days while in the other nests it ranged from 77-94 days (Table 2, Fig. 1). The duration of early care (H-R_1, H-R_2 in Fig. 1) was intended to allow absorption of residual yolk, closure of the umbilical scar and drying up of the point of attachment of chorio-allantois. For different nests the need for longer early care was proportionate to the incubation period. These were minimum in nest no. 1.2 and maximum in nest no. 1.4. Points R_1 and R_2 in Fig. 1 show the dates when the first and last hatchlings from the brood were released in the hatching pen. In the case of nest no. 1.2 'R' shows that all the hatc-

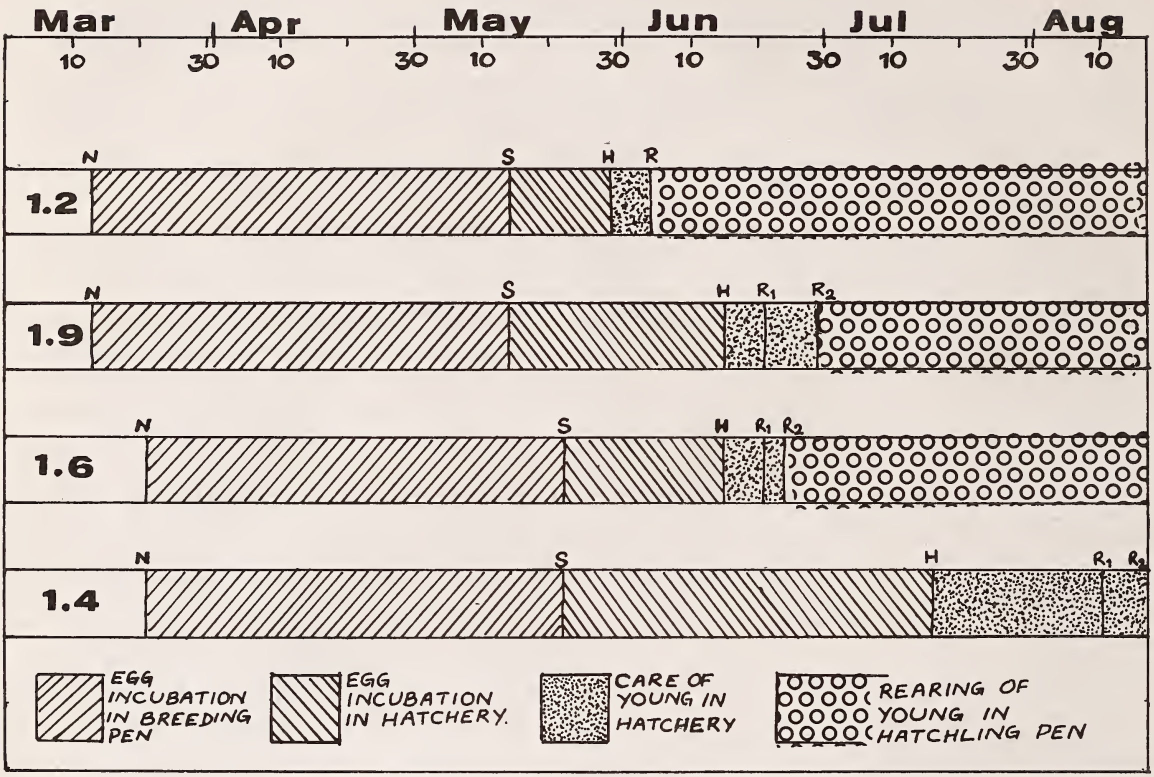

Fig. 1. Durations of incubation and post-hatching care in *Crocodylus palustris* at Ramatirtha during 1990. Nesting female nos. 1.2, 1.9, 1.6 and 1.4. Dates of nesting (N), shifting (S) of eggs from breeding pen to hatchery, hatching (4), release (R) of all hatchlings, release of first hatchling (R1) and last hatch ling (R2) of the brood.

hlings were fit for release on the same day, while in other nests the levels of fitness on any post-hatching date were different for different hatchlings.

No hatchling from nest no. 1.4 could hatch by itself. Hence these were helped out by opening the shell and shell membranes. All the hatchlings had distended abdomens due to large amounts of unabsorbed residual yolk, and all had strong bases of chorio-allantois attachment.

Out of total 19 hatchlings (Table 2) from nest no. 1.4 five (26.3%) had tail bends from the point where double whorl scutes and single whorl scutes meet. The bends permitted complete turn to the front while on stretching it straight the tail could return only half way to normal. Two other hatchlings (10.5%) had curved tail tips.

Discussion

The nest temperature for *C. palustris* in nature varies from 30°C to 34°C and the incubation period from 50 to 65 days (Groombridge 1982). Whitaker and Whitaker (1989) suggest

40-60 days incubation for the species. At Ramatirtha, incubation period for eight nests was 73 ± 3 days during 1988 and 1989 (unpublished data). The 77-117 (mean 93 ±17) days incubation observed during 1990 in the present study appears to have resulted from reduced temperatures caused by higher incidence of rainy days.

Nest no. 1.4 hatched 23-40 days after the other three nests of the season hatched. The delay is because on the 63rd day of incubation when the nest was shifted to the hatchery, the eggs were developmentally retarded. If the rate of development of *C. palustris* corresponds approximately to that of *Alligator mississippiensis, Crocodylus porosus* and *Crocodylus johnstoni* the eggs were at a maximum stage of only 40 days development.

Broods from nests with longer incubation periods, because of lower temperatures, required longer post-hatching care in the hatchery before the hatchlings could be released in the hatchling pens. This is due to unusually large amounts of residual yolk (Singh 1989). The quantity of residual yolk in the distended abdomens was more in hatchlings produced from low-temperature incubation.

This conforms to observations on *Alligator mississippiensis* by Ferguson and Joanen (1983) where the authors have further stated that because the rate of metabolism of poikilotherms is dependent upon the temperature of their surroundings, the eggs incubated at a higher temperature are likely to use more yolk for embryonic development and leave less 'residual yolk' than eggs incubated at lower temperatures.

The congenital defects of bent-tail and curled tail-tip are the same as observed in *Gavialis gangeticus* by Singh and Bustard (1982). The cause for the occurrence of congenital bent-tail may be due to less moisture in the nest sand during the latter half of incubation.

Summary

The incubation periods for four nests of *Crocodylus palustris* in a captive breeding pen were 77, 86, 94 and 117 days. Prolonged periods are attributed to a higher incidence of hailstorms and rain causing lower temperature and wide daily fluctuations in temperature and humidity. The longer the incubation period the longer also was the duration of post-hatching care needed before the hatchlings could be released in a fit condition to the rearing pens. The measures of 'fitness' were reduction in the quantity of residual yolk (hence reduced distension of the abdomen) and closure of the ventral skin at the point of attachment of the chorio-allantois. The nest with the longest incubation period and with reduced nest moisture (from 15% to 7-10% by weight towards the latter half of incubation) showed 26.3% cases of congenital tail bends and 10.5% instances of curved tail tips out of 19 hatchlings.

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GEOGRAPHICAL RANGE AND ECOLOGY OF THE VERRUCOSE FROG *RANA KERALENSIS* (DUBOIS)[1]

R. J. Ranjit Daniels[2]

The habits and call of *Rana keralensis,* a little known amphibian endemic to the Western Ghats, are described for the first time. The species can no longer be considered endemic to Kerala/Tamil Nadu as its range extends further north through Karnataka up to Maharashtra. It is a species of lower elevations (≤600 m) preferring streams flowing through dense forests. It is terrestrial and nocturnal. Egg-laying takes place at night even during the cool, dry months with night temperatures as low as 13°C. Eggs are laid at 5-16 day intervals in batches of over 200. Eggs float on the surface of water suspended by clear jelly and hatch into free swimming tadpoles in 48 hours. Hatching success may vary from 57-90%. Frogs emerge after 60 days. There is cannibalism in tadpoles and young frogs are devoured by juvenile *Rana tigerina* which share the habitat in nature.

Introduction

Studies on amphibians in India have not gone much beyond collecting and identifying species from selected areas. Probably the only study which has tried to bring out the habitat and niche preferences of amphibians in India is that of Inger *et al.* (1984, 1987). This study has however only included about a fifth of the over 100 species of amphibians hitherto known from the Western Ghats. Information on the rest is either non-existent or scanty (Inger and Dutta 1986). For most species, even the geographical ranges are not clearly known. Without knowing the geographic range and habitat requirements of species it will not be possible to deal with the problem of declining amphibian populations in our country, especially the Western Ghats where there is a concentration of species. It thus becomes necessary that more information on the ecology of each species of amphibian is documented alongside taxonomic and geographical notes.

Rana keralensis is an amphibian endemic to the Western Ghats. This was first described in 1875. However, Daniel (1975) has called this a 'little known' species. Inger *et al.* (1984) have added some details of its ecology, especially habitat and microhabitat preferences. The tadpoles were described by Annandale in 1915 (see Daniel 1975) and much later, notes were published on the food and feeding habits of the tadpoles (Mallick and Mallick 1981). In this paper I discuss some more details on the identification of the species in the field, its call, habits, food, habitat-microhabitat preference and breeding.

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General Description and Habits

After the species was first described as *Rana verrucosa* by Gunther in 1875, it was renamed in 1980 by Dubois as *Rana keralensis.* Gunther probably named it after the warty or verrucose dorsal surface of the frog (hence I call it the verrucose frog), which is an identification character in the field. Adults vary in snout-vent length from 35 to 60 mm (males being smaller). They can be pale ochraceous brown, brown or almost black dorsally and fully white ventrally. These colour forms can be seen even among freshly metamorphosed frogs of the same brood. Colour varies with the habitat in which they are found, camouflaging the frog remarkably against the background such as wet soil or a rock. Individuals can also change colours rather rapidly to suit the background.

Dorsal colour pattern includes short black streaks which are often hidden in the darker forms. All adults have yellow and black marbling on the rear surface of thighs. A diamond-

shaped golden spot is present on the back of most individuals even when young. Eyes are black and dilatable; the pupil is round and reflects red against light at night. Overall colour pattern resembles the commoner cricket/paddy field frog *Rana limnocharis*. However *keralensis* is stockier, with the hump on the back more pronounced at rest. Larger eyes protruding more abruptly above the head, shorter snout and the absence of balloon-like vocal sacs when calling are further pointers that distinguish the species from *limnocharis* in the field.

The species is largely nocturnal. Adults that I have seen and collected were mostly resting during the day and foraging at night. They tend to hide, unlike the juveniles which are more often encountered during the daytime. In captivity, both adults and juveniles feed during the day. This frog is not very timid and if disturbed takes only short leaps. Wherever there is water individuals dive in, in an attempt to escape. However they surface soon (if not immediately) some distance away.

Voice and calls: I have not heard this species in the wild. However, males in captivity were very vocal both during the night and day in June and all through the rainy season. Males start calling as soon as it is cloudy and after a sudden shower of rain. The typical call is a series of 9-11 rather aggressive croaks: *crok crok crok crok...crok*. Males also produce a series of softer *chucks* when combatting a rival male. Juvenile frogs (20–24 mm snout-vent) often called during the afternoons. The calls were very soft and insect-like: *check check chekka chekka chekka...chek*. The significance of this call is not clear though it often coincided with cloudiness.

Food and feeding: Both adults and juveniles feed readily in captivity. Juveniles eat small grasshoppers and moths, termites (wingless) and caterpillars. Adults consume grasshoppers, moths and winged termites. Earthworms are readily accepted. An adult female once even ate a castor moth *Pericallia ricini*. Cockroaches *Periplaneta americana* are taken in all sizes. A female frog 55 mm snout-vent can swallow adult cockroaches.

All insects are picked up from the surface though occasionally some are caught flying. The frogs are not good at foraging in deeper water where they have to swim or float. When larger insects have to be tackled, the forelegs are used. While dealing with large moths the forelegs are used to break off the wings before the body is swallowed.

Geographical range: The range of *Rana keralensis* has been given as the Western Ghats of Kerala and Tamil Nadu (Daniel 1975, Inger *et al.* 1984, Inger and Dutta 1986). I found that this species extends much further north along the Western Ghats. While its southern limit of distribution lies in the hills of the Kanyakumari district where this species is very common (June), its northern limit is Maharashtra. I failed to find this species in Silent Valley (December) and Peechi (February). However I found juveniles in Neria and Byndoor (Dakshina Kannada, September-November) in coastal Uttara Kannada (after the rains) and surprisingly an adult female in Rohaghat (south-western Maharashtra, October). The species has been reported to occur in Goa as well (Sekar 1991).

Habitat and microhabitat: Of all vertebrates, amphibians are probably more choosy about habitats and microhabitats due to their bimodal life-style and very sensitive skin. *Rana keralensis* has a preference for humid habitats. Streams flowing through evergreen or semi-evergreen forests seem to be the most preferred habitat of the species. Inger *et al.* (1984) collected the species at Ponmudi in evergreen, secondary and moist deciduous forests, forest clearings and rubber plantations. 50% of their collections were away from water. I have also come across this species in degraded forests, rubber and exotic plantations and paddy fields in forest clearings in various parts of the Western Ghats. However, I have always found this species close to a stream or a source of water. I

found the species away from water only during rainy nights. The study at Ponmudi was during May-June, the beginning of the rains. Hence Inger *et al.* (1984) collected a considerable proportion of their frogs away from water.

According to Inger *et al.* (1984) *R. keralensis* is terrestrial. They collected most of their specimens from leaf litter. Fewer individuals were found on rocks and bare soil. I found the species equally common in grass/leaf litter (when wet), bare wet soil along the edge of streams and on exposed rocks just above the surface of water. Juveniles sit beneath leaves with only their heads showing in shallow seepage pools across paths. Juvenile frogs in captivity prefer to sit between dead leaves in wet areas. Adults make cavities in wet soil at the edge of water, sitting exposed (though well camouflaged) or under cover of a piece of wood or rock.

Tadpoles have been collected from shallow muddy channels across roads and from potholes in rocks (Inger *et al.* 1984). I have not seen the tadpoles in the wild but have seen metamorphosing frogs in similar situations. Shallow channels in betelnut orchards are favourite breeding spots in Uttara Kannada (Karnataka). In captivity tadpoles were equally at home in deeper pools as well as a shallow channel with flowing water. However, development appeared to be faster in cooler water where the day temperature never exceeded 27°C as against the pool in which water temperature reached 30°C during the day.

Daniel (1975) has given the altitudinal range of this species as up to 2000 m. Inger *et al.* (1984) have, however, found this species mostly at altitudes of 100-300 m. This is probably more of a local phenomenon as the study of Inger *et al.* was limited to Ponmudi, a small part of Kerala. My observations over the Western Ghats suggest that this species is equally common at altitudes less than 100 m and between 450-600 m. I have not seen this species anywhere above 600 m. Despite evidences of its occurrence at higher elevations, viz. 710 m (Inger *et al.* 1984) and that of Daniel (1975), it might be considered that this species prefers lower elevations, where it is certainly commoner.

Breeding and development: One male that I had collected in the hills of Kanyakumari district during June measured 35 mm snout-vent and was ready to breed. It was calling all through the night and early morning from within the box in which I had kept it. In August this male and two other males (40 and 37.5 mm snout-vent) were showing signs of breeding when a 55 mm female was introduced into their cage. There was a lot of aggression demonstrated by the males over the female. Males fought while calling agitatedly. Each tried to push the other out from what appeared to me a small, actively defended territory. A territorial male would leap from one position to another, driving out the other males and then on to the female, grabbing her from whichever end was within reach. The female, however, took no interest and always tried to kick the males off. Males persisted in clinging on to her and to the extent that she had to do all her feeding with a male on her back.

The female laid its first batch of eggs only in January after it was introduced into a large outdoor cage with flowing water, plants and litter on the ground. The eggs were like mustard seeds in clear jelly. 75% of the egg masses were in deep water (230 mm) and the rest in water less than 25 mm deep.

Number of eggs varied from 7 to 115 per mass. These were spread between two deep pools which are about 3 m apart and along the shallow channel connecting them. This suggests that the laying female was moving about. All laying took place during late night without any prior indication in the evening. Therefore the exact process and behaviour was not observed.

Table 1 gives the details of egg-laying. This species of frog seems to be able to breed under a wide range of temperatures (daily range 10–

TABLE 1

EGG-LAYING IN *Rana keralensis* WITH DETAILS OF PERIODICITY, WEATHER CONDITIONS AND NUMBER OF EGGS LAID

Sr. No.	Date	Temperature (Range °C)	Relative Humidity %	Number of clusters	Deep/ Shallow	Number of eggs per cluster	Total
1.	2.1.1991	—	—	—	—	—	200
2.	18.1.1991	17-27	32-52	9	4/5	12-47	235
3.	23.1.1991	15.5-28	19-52	4	2/2	37-81	269
4.	31.1.1991	13-28	35-52	9	7/2	12-56	260
5.	5.2.1991	15.5-30	13-40	4	4/0	15-115	260
6.	19.2.1991	16-31	11-15	5	5/0	14-35	133
7.	23.4.1991	20.5-34	20-52	7	7/0	7-55	203
8.	11.5.1991	—	—	4	4/0	10-21	56

*Range during the daytime between 1000 and 1700 hrs

15°C) and fairly low relative humidity. Night temperature was as low as 13°C at least once and the relative humidity during the day was never more than 52%. A series of six broods were produced with an interval of 5–16 days. With one exception (133) the total number of eggs per brood was between 200 and 269. After over two months, another batch of eggs was laid. This was probably the beginning of a fresh series as after 18 days on 11 May 1991, the next batch of eggs was laid. Therefore, only the first six broods are discussed.

First hatching was 30 hours after laying. Hatching was delayed by 10–12 hours in another pool where the water temperature was 2.5–3.0°C warmer during the day. 57-90% of the eggs hatched. Tadpoles were brown, elongate (resembling mosquito pupae) and within the jelly. 48 hours after laying and 18 hours after the first hatching the tadpoles started swimming free.

Tadpoles are bottom feeders and under the microscope appear transparent, with the scattered brown pigments being darker on the back. Mallick and Mallick (1981) note that the tadpoles are initially herbivorous, taking slowly to animal food and to cannibalism. All these were observed in my study as well. Tadpoles gathered around a source of animal food such as a dead grasshopper and devoured it. Older tadpoles attacked and devoured the eggs that were in shallow water. Younger tadpoles were probably devoured too, as their numbers started coming down rapidly as the first batch of tadpoles were growing. Individuals were often found dead. There were also physical deformities like bent backs and tails in tadpoles.

The first batch of tadpoles showed hindlegs 45 days after hatching and 15 days later juvenile frogs appeared. There were, however, only 15 young frogs that developed despite the 200 eggs laid in the first batch. The number of frogs that developed from the subsequent batches could not be monitored as the different broods mixed together in the same pool and tadpoles were rapidly vanishing. Freshly metamorphosed frogs were less than 10 mm snout-vent and stayed close to the source of water from which they emerged after a period of three weeks. After this period the frogs dispersed over wet soil and litter. Frogs 60 days old measured 15 mm snout-vent.

During various stages of development, eggs and tadpoles were subject to both cannibalism and to other predators. The number of tadpoles started declining rapidly after one of the pools was occupied by a large female *Rana hexadactyla.* An adult *Rana cyanophlyctis* moving between the pools could have also devoured some of the tadpoles. Metamorphosing frogs were devoured by a juvenile *Rana tigerina.* I have seen juvenile *tigerina* (15–25 mm) stay singly in pools where larval *keralensis* emerge as frogs. I have also witnessed a *tigerina*

of this size easily swallowing young *keralensis* of 10 mm length. One of the small *tigerina* collected earlier with juvenile *keralensis* is now over 70 mm long and in the same cage as these breeding frogs. This frog temporarily occupied the edge of the pool throughout the period when *keralensis* tadpoles were metamorphosing into frogs.

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ON THE TAXONOMY AND ECOLOGY OF ROTIFERS IN FISH PONDS[1]

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(*With nine text-figures*)

Taxonomic accounts and ecology including weekly abundance of rotifers, other than *Brachionus,* are reported from four fish ponds in Tuticorin during a fish culture season (November 1986 to March 1987). Eight species of rotifers, viz. *Asplanchna brightwelli, Filinia longiseta, Hexarthra (Pedalia) intermedia, Keratella tropica, Lecane luna, L. (Monostyla) bulla, Polyarthra vulgaris* and *Testudinella patina* present in the ponds have been described and illustrated. Of these, *K. tropica* and *F. longiseta* were predominant. *Hexarthra (Pedalia) intermedia* is a new record from India.

INTRODUCTION

Rotifers play a pivotal role in the planktonology and productivity of freshwater systems, for they often predominate in plankton populations. Further, they feed extensively on, and thus control, the phytoplankton and other zooplankton populations. There is a paucity of knowledge on the taxonomy and ecology of rotifers from southern Tamil Nadu. I had earlier (Sampathkumar 1991) reported on the genus *Brachionus.* The present communication discusses the taxonomy and distribution, both temporal and spatial, of eight other taxa of rotifers (belonging to seven genera) in freshwater fish ponds in Tuticorin, south Tamil Nadu.

MATERIAL AND METHODS

The present investigation was carried out in four fish ponds (designated ponds 1, 2, 3 and 4) located in the premises of Fisheries College, Tuticorin from November 1986 to March 1987. Weekly collections of rotifers were made from the ponds using a plankton net of 60μ m mesh size between 0600 and 0800 hrs. The samples, after preservation in 5% buffered formalin, were analysed (qualitatively and quantitatively). Hydrographic parameters, viz. water temperature, pH and dissolved oxygen (estimated by Winkler's titration) were measured concurrently. The pH values are not presented here since they showed little variation, and because rotifers have been found to be insensitive to pH (Haque *et al.* 1988).

RESULTS AND DISCUSSION

The eight taxa of rotifers recorded were *Asplanchna brightwelli* (Gosse, 1850), *Filinia longiseta* (Ehrenberg, 1832), *Hexarthra (Pedalia) intermedia* (Wisniewski, 1929), *Keratella tropica* (Apstein, 1907), *Lecane luna* (Muller, 1786), *L. (Monostyla) bulla* (Gosse, 1851), *Polyarthra vulgaris* (Carlin, 1943) and *Testudinella patina* (Hermann, 1783). Of these, *A. brightwelli, K. tropica* and *F. longiseta* were present in the ponds frequently and predominated the zooplankton populations. *L. (M.) bulla* showed a rare occurrence.

DESCRIPTION OF THE TAXA AND THEIR ECOLOGY

Keratella tropica (Apstein, 1907)

Body loricate. Lorica depressed and ornamented with polygonal facets on the dorsal surface. Ventral surface smooth. Occipital margin with three pairs of spines of which medians are the longest and curved posteriorly. Posterior end of lorica with two lateral spines, the right being longer than the left. Length of lorica: 116μ m (Fig. 1).

Ecology: *K. tropica* was recorded in large numbers during late November to early December 1986 and thereafter it disappeared. It was

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TABLE 1
LIST OF SPECIES DESCRIBED

Phylum	:	ROTIFERA
Class	:	Monogononta
Order	:	Ploima
Family	:	BRACHIONIDAE
		Keratella tropica (Apstein, 1907)
Family	:	ASPLANCHNIDAE
		Asplanchna brightwelli (Gosse, 1850)
Family	:	LECANIDAE
		Lecane luna (Muller, 1786)
		L. (Monostyla) bulla (Gosse, 1851)
Family	:	SYNCHAETIDAE
		Polyarthra vulgaris (Carlin, 1943)
Order	:	Flosculariacea
Family	:	TESTUDINELLIDAE
		Testudinella patina (Hermann, 1783)
		Filinia longiseta (Ehrenberg, 1832)
Family	:	HEXARTHRIDAE
		Hexarthra (Pedalia) intermedia (Wisniewski, 1929)

The classification of the taxa has been made in accordance with Ruttner-Kolisko (1974).

altogether absent in Pond 1 (Fig. 9).

It has been reported from India in various freshwater environments–tanks in West Godavari and Ootacamund (Dhanapathi 1974); ponds in Sambalpur (Sharma 1981); and sewage channels in Gwalior (Saksena and Kulkarni 1986).

Asplanchna brightwelli (Gosse, 1850)

Lorica very large and without spines. Vitellarium horse-shoe shaped. Trophi incudate. Length of lorica: 280μ m (Fig. 2).

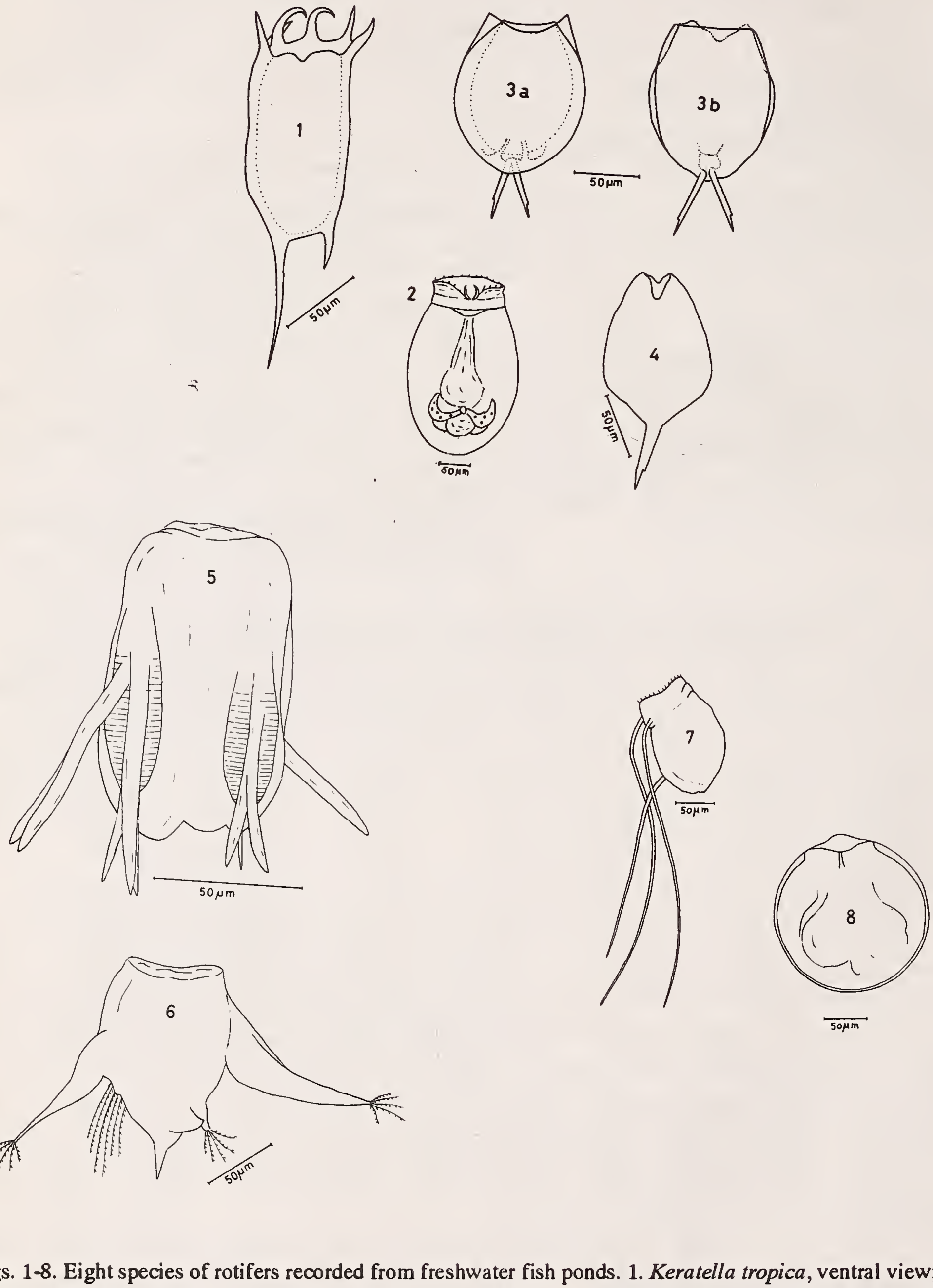
Ecology: This species dominated the rotifer population, occurring frequently in large numbers during the latter half of the culture period (9 January to 13 March 1987) when the population of the other species had diminished or disappeared, presumably due to its extensive feeding (Fig. 9).

It was earlier recorded in Kaila Sagar tank, Gwalior (Saksena and Sharma 1983).

TABLE 2
WATER TEMPERATURE AND DISSOLVED OXYGEN IN FISH PONDS

Pond No. Date:	8.11.86	15.11.86	22.11.86	29.11.86	6.12.86	13.12.89	19.12.86	27.12.86
Temperature (°C)								
1	29.0	29.0	27.5	27.0	27.0	28.0	24.5	24.0
2	31.0	30.0	27.5	27.5	28.5	29.0	25.0	24.5
3	31.0	30.0	28.5	28.5	29.5	29.5	24.0	24.5
4	31.0	30.0	28.5	29.0	28.5	29.5	25.5	25.0
Dissolved Oxygen (ml/1)								
1	7.25	5.39	4.66	5.28	5.33	5.70	8.70	3.62
2	6.63	5.18	4.14	6.83	4.82	6.42	4.14	1.61
3	8.63	5.18	5.39	3.31	4.56	5.70	4.76	1.61
4	8.74	6.77	4.35	6.06	6.01	4.76	6.00	1.81

Pond No. Date:	2.7.87	9.1.87	16.1.87	23.1.87	30.1.87	6.2.87	13.2.87	20.2.87	27.2.87	6.3.87	13.3.87
Temperature (°C)											
1	27.5	27.0	26.5	26.5	26.0	23.5	28.0	27.0	27.0	30.0	28.5
2	28.0	28.5	26.0	26.5	26.0	24.0	28.5	27.0	26.5	31.5	30.0
3	28.0	30.0	27.0	26.5	27.0	25.0	29.0	28.5	28.0	31.5	31.0
4	28.0	30.0	27.5	27.5	27.5	25.6	30.0	28.5	28.0	32.0	31.0
Dissolved Oxygen (ml/l)											
1	4.34	2.01	4.04	2.79	2.48	2.88	0.85	2.26	3.04	1.49	2.13
2	4.82	3.94	4.09	3.90	3.18	4.11	4.27	4.32	4.86	1.70	3.20
3	5.71	4.74	6.11	4.26	3.32	5.87	4.59	3.91	3.55	0.60	7.67
4	7.07	3.62	7.04	5.00	4.86	3.95	5.28	2.37	4.16	2.19	3.41



Figs. 1-8. Eight species of rotifers recorded from freshwater fish ponds. 1. *Keratella tropica*, ventral view;2. *Asplanchna brightwelli*, dorsal view; 3. *Lecane (Lecane) luna*, a. dorsal view, b. ventral view; 4 *Lecane (Monostyla) bulla*, ventral view; 5. *Polyarthra vulgaris*;6. *Hexarthra (Pedalia) intermedia*; 7 *Filinia longiseta*; 8. *Testudinella patina*.

Fig. 9. Weekly distribution and abundance of rotifers. a-d, Ponds 1-4 respectively.
+ *Asplanchna brightwelli* ▲ *Filinia longiseta* ■ *Polyarthra vulgaris* ● *Keratella tropica*
○ *Testudinella patina* □ *Lecane (Monostyla) bulla* △ *Hexarthra intermedia* ◐ *Lecane luna.*

Lecane (Lecane) luna (Muller, 1786)

Lorica slightly elongate. Occipital margin forming a wide V-shaped sinus with external angles sharp but not spiny. Antero-ventral margin narrow and plane. Foot with two diverging toes. Length of lorica: 120μ m (Fig. 3).

Ecology: *L. (L.) luna* was present in small numbers in November 1986 in ponds 3 and 4 (Fig. 9).

It has been reported earlier from different parts of India (Naidu 1967, Sharma 1981, Saksena and Kulkarni 1986).

Lecane (Monostyla) bulla (Gosse, 1851)

Lorica oval with narrow anterior and broad posterior ends. Occipital margin with a shallow notch at the centre. Antero-ventral margin forming a deep sinus. Foot with a single toe. Length of lorica: 120μ m (Fig. 4).

Ecology: This species was recorded only once (30 January 1987) but in large numbers (Fig. 9). Sharma (1981) recorded *L. (M.) bulla* in Sambalpur and Saksena and Kulkarni (1986) in Gwalior.

Polyarthra vulgaris (Carlin, 1943)

Body cylindrical and illoricate. Foot absent. 12 paddles, long cuticular appendages present. Paddles slightly longer than body. Length of lorica: 100μ m (Fig. 5).

Ecology: This rotifer was present in the ponds during mid November to mid December 1986 except in pond 1 (Fig. 9).

Hexarthra (Pedalia) intermedia (Wisniewski, 1929)

Body conical and illoricate with five unequal, muscular and setose arms, four lateral and one ventral. Five teeth are present on either side of the trophi. Length of body: 126μ m (Fig. 6).

Ecology: It occurred in pond 3 from 6 March to 13 March 1987 in moderate numbers (70–400 organism/l). *H. intermedia* has not been recorded earlier in India.

Filinia longiseta (Ehrenberg, 1832)

Body illoricate, elongate and cylindrical. Three setae present. Two setae long (520μ m) and arise from the anterior sides. The third seta relatively short (280μ m) and arises from the posterior ventrum. Length of body: 140μ m (Fig. 7).

Ecology *F. longiseta* occurred frequently during November and December 1986 with populations ranging from 12 to 2000 organisms/l when the water temperature fluctuated around 27°C. It was rare from January to March 1987 (Fig. 9). *F. longiseta* has been recorded commonly in many parts of India.

Testudinella patina (Hermann, 1783)

Body loricate. Lorica circular and depressed. A retractile and annulated foot with a ciliated distal end present. Diameter of lorica: 180μ m (Fig. 8).

Ecology: This species occurred in November and December 1986 in varying concentrations (0 to 400 organisms/l) except in pond 1. *T. patina* has been reported so far from West Bengal (Tiwari and Sharma 1977), Orissa (Sharma 1981) and Andhra Pradesh (Naidu 1967).

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TAXONOMY OF MAHSEER FISHES OF THE GENUS *TOR* GRAY WITH DESCRIPTION OF A NEW SPECIES FROM THE DECCAN[1]

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(With five text-figures)

Introduction

There has been a severe decline of large, piscivorous barbins of the genus *Tor* Gray throughout much of their range from Indonesia, across southern Asia to Pakistan, including the Indian peninsula. The group has an extremely confusing literature and taxonomy because of the types of morphological variations they exhibit. Hora (1936-43) in a series of articles on Game Fishes of India consolidated the information on the taxonomy of mahseers to a great extent. Sen and Jayaram (1982) reviewed the literature on mahseers in India and restricted the term mahseer to members of the genus *Tor*. In the present paper an attempt is made to define the specific limits of the various species of *Tor* after a critical statistical study of the various characters of the different populations occurring in major river systems of India and Burma.

In dealing with the problem of mahseer taxonomy it is necessary to mention an important nomenclature problem with the name *Hypselobarbus* Bleeker, 1859, a poorly known genus of peninsular India. *Hypselobarbus* with type *Barbus mussullah* Sykes, 1840, was erected by Bleeker in 1859 based on Sykes' illustration of *Barbus mussullah.* This illustration, however, turned out to be controversial and Hora (1942, 1943) considered the fish depicted to belong to the genus *Tor* Gray, 1833, on the assumption that Sykes' illustration was incorrect. If *mussullah* were treated as a member of the genus *Tor*, then *Hypselobarbus* would have become a subjective synonym of *Tor* Gray. But Rainboth (1989) rightly pointed out that *Barbus mussullah* does not belong to *Tor* Gray, making available the name *Hypselobarbus* for the poorly known, highly endangered large barbels of the Indian peninsula. *H. mussullah* (Sykes), *H. kolus* Sykes (=*H. curmuca* Ham.), *H. dubius* (Day), *H. lithopidos* (Day), *H. micropogon* (Val.), *H. periyarensis* (Raj.), *H. thomassi* (Day) and *H. kural* sp. nov. belong to members of this genus.

The hump-backed *Tor* from the peninsula so far named as *T. mussullah* (Hora, loc. cit., p. 6) is considered the same as *T. khudree* (Sykes). A new species discovered from the Darna river (Godavari drainage), Deolali, is described here as *T. kulkarnii,* after Dr. C.V. Kulkarni, Director of Fisheries (Retd.), Maharashtra, in recognition of his outstanding contributions to mahseer conservation in India.

Review of Literature

The earliest species of mahseers described are those by Hamilton in 1822. He described three species, i.e. *Cyprinus putitora, C. tor* and *C. mosal.* Hamilton did not figure any one of the three species in his work on FISH GANGES but he left two drawings — one of *C. tor* and another of *C. mosal*—among his manuscript drawings now preserved in the library of the Asiatic Society of Bengal. Gray (1833) published these drawings which Hardwicke assembled from various sources in his work ILLUSTRATIONS OF INDIAN ZOOLOGY under the names *Cyprinus mosal* Hamilton (Gray I, pl. XCIII, fig. 1). His publication of *Cyprinus tor* under the generic name *Tor* with *Cyprinus tor* Hamilton (= *Tor hamiltonii)* as its haplotype has antidated Ruppell's *Labeobarbus* (1836) by which name the mahseers of the Asiatic mainland and the Indo-Australian archipelago were designated by Bleeker (1860) and used by Weber and de

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Beaufort (1916), Gunther (1868), Vinciguerra (1879), Fowler (1905, 1935) and others.

After Hamilton, Sykes (1838) described *Barbus khudree* from Mula-Mutha river, 8 miles east of Poona. In the same year Heckel added one more species to the Indian game fish fauna from Kashmir Valley under the generic name *Labeobarbus, L. macrolepis* which is synonymous with *T. putitora* (Ham.).

In 1839, McClelland in his account of the Indian Cyprinidae dealt with large-scaled barbels of India and described five species, viz. *Barbus hexasticus, B. progeneius, B. macrocephalus, B. hexagonolepis* and *B. megalepis.* The first four were described from Assam while the last species was obtained in river Kosi. Of these, *B. hexagonolepis*, according to modern nomenclature, is *Neolissochilus hexagonolepis, B. hexasticus* and *B. megalepis* are synonymous with *Tor tor* (Ham.), *B. macrocephalus* with *Tor putitora* (Ham.), and only *B. progeneius* is a valid species.

Jerdon (1849), in his paper on "freshwater fishes of Southern India" described from the mountain streams of Malabar, *Barbus malabaricus* which I have synonymised with *T. khudree* (Sykes) in this paper.

Day in his FISHES OF INDIA (1878) and THE FAUNA OF INDIA (1889) lumped Hamilton's *C. putitora, C. tor* and *C. mosal* together under a single species *Barbus tor* and used *B.tor* as a collective name for the various species of mahseer found in India. On the other hand, Gunther (1868:130) used the name *B. mosal* as the collective name for all the Indian species of mahseer. Day, however, retained McClelland's *B. hexasticus* as a distinct species and characterised it as "lips moderately thick, the lower one without or with a badly developed lobe, but having a shallow and continuous transverse fold. Sometimes pores on snout". Evidently his *hexasticus* is a composite species comprising of both *T. tor* (Ham.) and *Neolissochilus hexagonolepis* (McClell.). Strangely enough, Day in his work overlooked Sykes' *B. khudree* though he (Day 1868) described a new species, *B. neilli* from the Thungabhadra river at Kurnool, South India, which is the same as *T. khudree* (Sykes). The lumping of all the species of mahseer found in India into a single species by Day was, however, not agreed to by anglers, who were of the opinion that there were more species of mahseer than named. Thomas (1897) in his famous book THE ROD IN INDIA stated:

> "Further experience has confirmed me in the view advanced in 1873 that there are more Mahseers than have been named, and that if it were possible that as much accurate attention could be given the Mahseer as has been devoted to the Salmonidae of Great Britain, of Europe, and America, it would be found that the Mahseer of India would likewise grow in numbers".

Hora and Mukerji (1936) and Hora (1939-1943) attempted to identify the probable valid species of mahseer and define their precise taxonomic limits giving valuable information on their ecology and bionomics. Hora and Mukerji (1936:140) as a result of the extensive collections made by them in the Eastern Doons, described the specific limits of the three species described by Hamilton and concluded that *C. putitora* is abundantly distinct from *C. tor* but may be conspecific with *C. mosal.* They (loc. cit., p. 140) further observed:

> "If all the characters in the descriptions of the three species are tabulated, it is found that *C. putitora* and *C. mosal* have much in common and are abundantly distinct from *C. tor.* In *C. putitora* and *C. mosal* the dorsal in front of the dorsal fin slopes and forms a sharp ridge, whereas in *C. tor* the surface in front of the dorsal fin has a blunt or convex edge. While examining fresh specimens we could easily separate the yellow finned form and the red fin form, and these colour groups can be further distinguished by certain well marked taxonomic characters. In the specimens with red fins, the length of the head is contained more than 4 times and the depth of the body less than 4 times in the total length without the caudal fin, whereas in the examples with yellow fins the length of the head is less than 4 times in the total length without the caudal. Among the yellow finned form there are two types:
>
> (i) The lips are fleshy and the lower one is produced backwards into a long fleshy appendage; the snout is blunt.
> (ii) The lips are of normal type and the lower lip does not form an appendage; the snout is rather pointed.

We believe that these differences are correlated with sex; the former type represents the male and the latter the female. As these are the differences on which Hamilton separated *putitora* from *mosal*, we regard them as conspecific and on account of page priorities adopt the former name for the species".

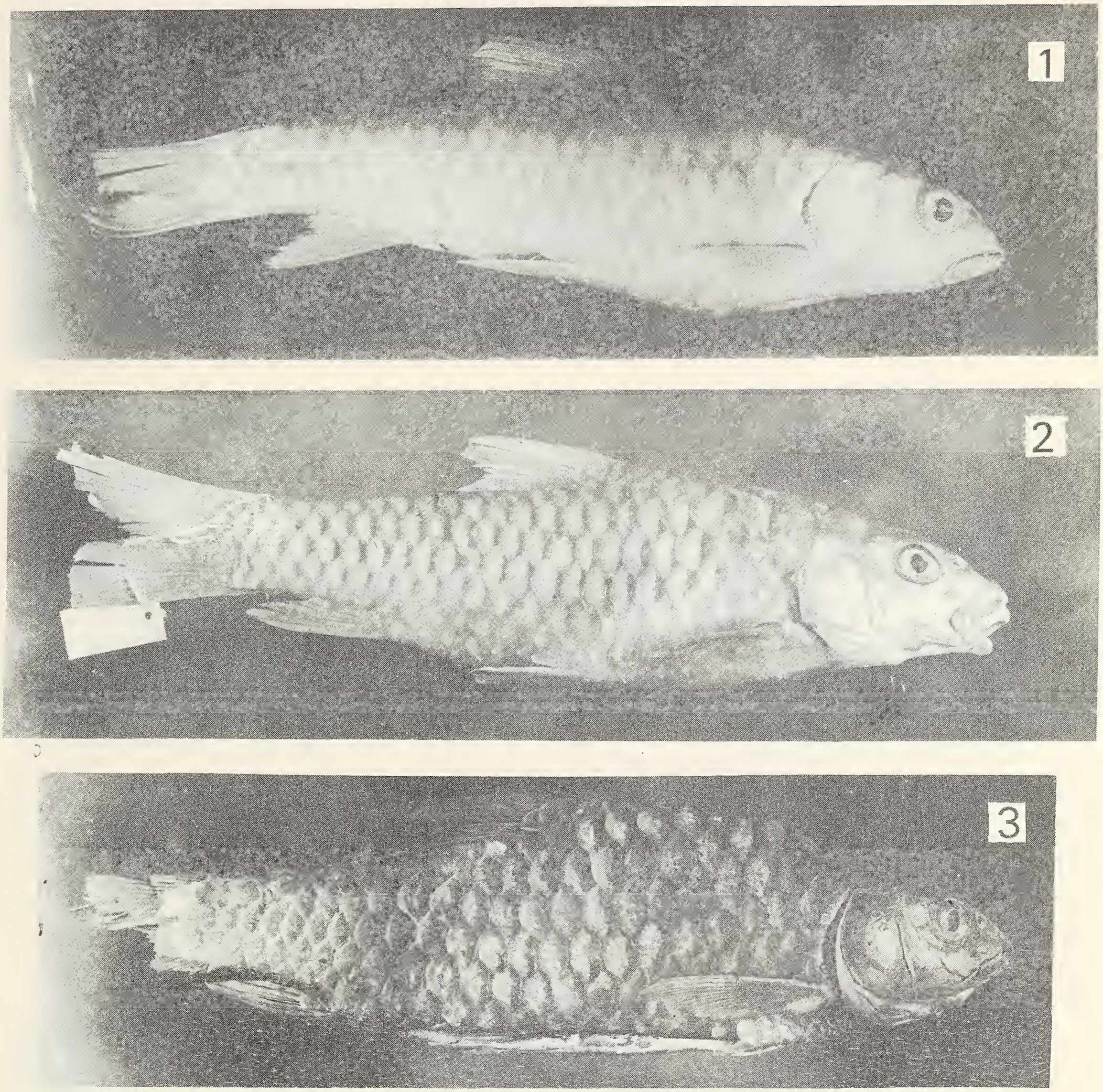
From the above observation of Hora and Mukerji and a re-examination of Hamilton's original illustration of *C. mosal*, I am convinced that Hamilton's *C. putitora* and *C. mosal* are one and the same species, the nature of their lips being an adaptive character *(vide infra)*.

In 1939, Hora dealt with the *Putitor* mahseer, *Barbus (Tor) putitora* (Ham.). It may be mentioned here that the genus *Barbus* (*sensolato*) having about 500 species, is distributed from central China, the Philippines and Borneo to Spain and South Africa (Myers 1941). This vast genus has been treated as such by Gunther (1868), Day (1878), Rendahl (1928) and Nichols (1943) though many authors like Weber and de Beaufort (1916) and Smith (1945) have attempted to subdivide it without much success. Hora used the generic name *Barbus* and recognised *Tor* Gray as its subdivision. In the present paper I have recognised *Tor* Gray as a distinct genus though the generic status of a number of barbins of southern and south-eastern Asia is poorly understood at the moment (*vide* Rainboth, loc.cit., p. 24).

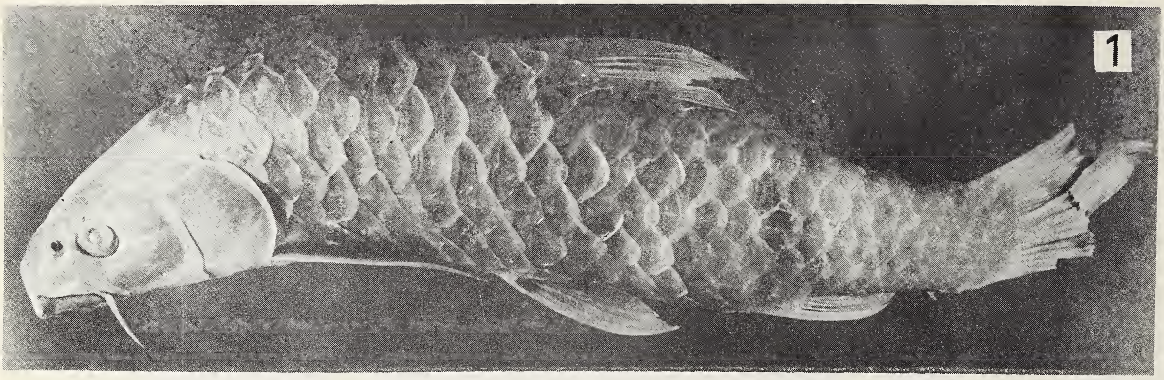
Hora (loc. cit., p. 281) studied the differences in the structure of the lips and concluded that the fleshy hypertrophied lips with lower lips produced into a fleshy appendage are characteristic of individuals inhabiting shallow torrential streams with rocky and gravelly beds, and those with normal lip- type without any enlarged appendage on the lower lip and a pointed snout are denizens of comparatively sluggish streams with sandy and pebbly bed. They are neither secondary sexual characters nor do they represent distinct species. The hypertrophied lip, is applied to the substratum to form a sucker to enable the fish to adhere to rocks and stones in a shallow torrential stream.

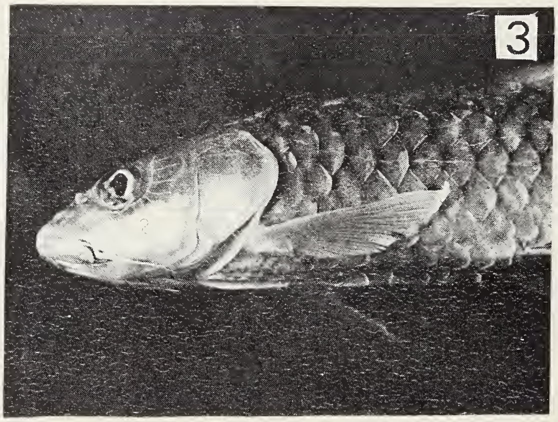
In 1940, Hora discussed Hamilton's second species of the large scaled barbels of India, *Barbus (Tor) tor* (Ham.), characterising it as a form in which the head is considerably shorter than the depth of the body and the lower fins reddish in colour. Hora (1940a) also recognised the specific validity of Hamilton's third large scaled barbel, *Cyprinus (cyprinus) mosal*. Though Hora considered Hamilton's *Cyprinus mosal* with ordinary lips as female representing *Barbus (Tor) mosal* and the form with enlarged lips as male representing *Barbus (Tor) putitora*, he subsequently argued that Hamilton's *mosal* was more closely allied to *tor* than to *putitora*. Based on Gray's illustration of *Cyprinus mosal*, he drew certain salient features of his *mosal* that distinguish it from *Barbus (Tor) putitora* and *Barbus (Tor) tor*. He considered that in *Barbus (Tor) mosal* the depth of the body is more or less equal to the length of the head (considerably greater in *Barbus (Tor) tor* and considerably less in *Barbus (Tor) putitora);* the dorsal profile is more elevated than the ventral, the head is sharpish in front and the dorsal spine is very strong. However, in Hamilton's original drawing of *Cyprinus mosal* the depth of the body is somewhat less than the length of head while in Hora's colour sketch of *Barbus (Tor) mosal* from the Mintha stream, Tavoy, Burma, the depth of body is considerably greater than the length of head as in typical *Tor tor* (Ham.). Hora further stated that in the collections of the Indian Museum, *Barbus (Tor) mosal* is represented by a few specimens and even these are mostly from Burma. From the specimens I have examined from Upper Burma in the collections of the Zoological Survey of India and from the results of the statistical analysis of characters of populations of the deep-bodied forms with length of head about four times in SL from Burma, Assam, the Himalayas and the Satpura-Vindhya ranges I have come to a definite conclusion that all these populations belong to *T. tor* and Hora's *T. mosal* is synonymous with it (see Fig. 1 graph 1).

In 1941 Hora defined the specific identity

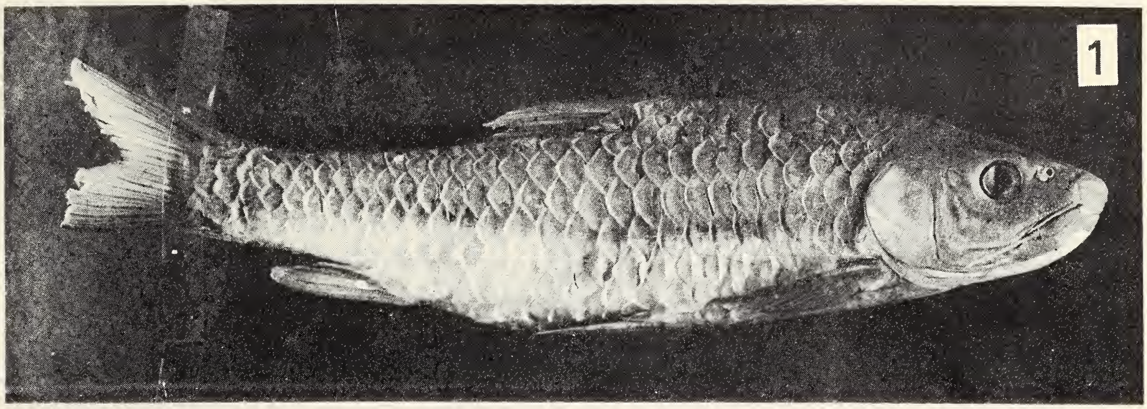


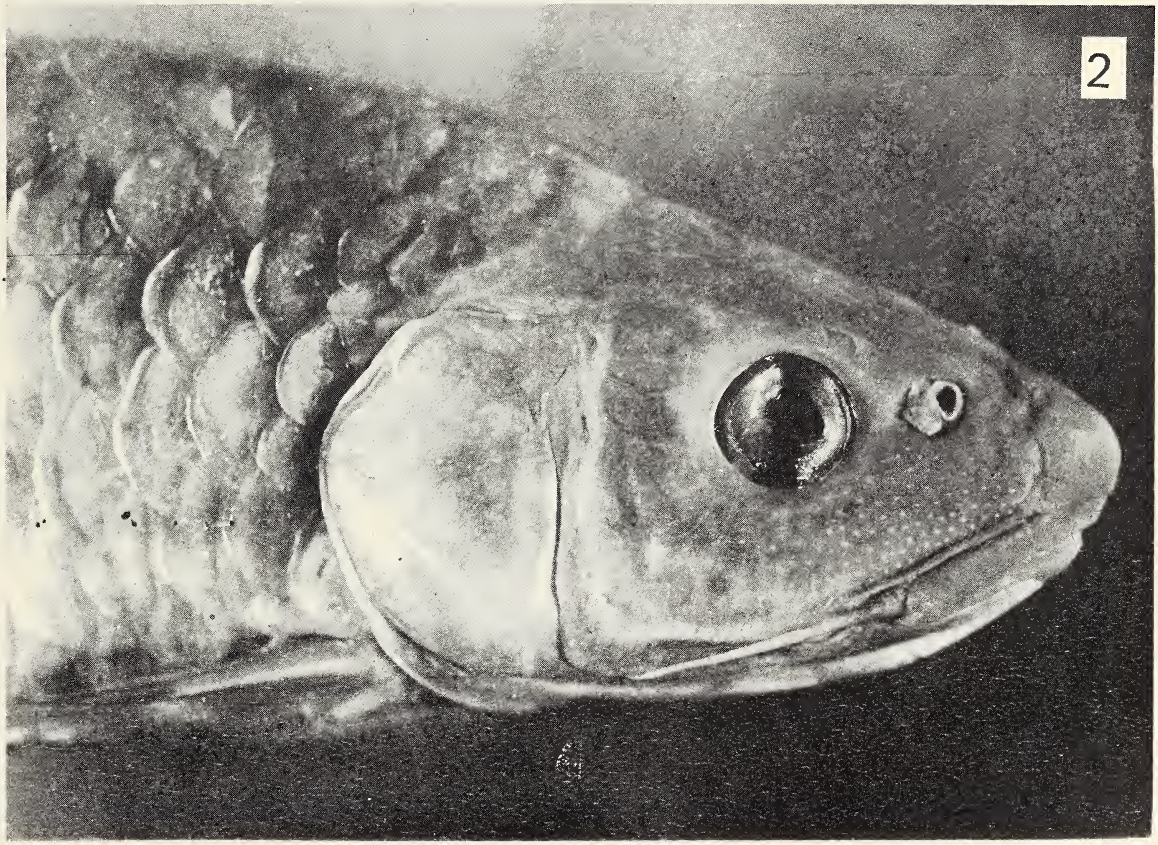
Species of mahseer. 1. *Tor khudree* (Sykes) from Krishna river, Satara Dt., Maharashtra, 115 mm SL. 2. *Tor tor* (Ham.) from Suswa river, Dehra Dun, 126 mm SL. 3. *Tor kulkarnii* sp. nov. from Darna river, Deolali, Maharashtra, 200 mm SL.





Species of mahseer: 1. *Tor putitora* (Ham.) from Assam, 300 mm SL. 2. *T. putitora* (Ham.) from Tawi river, Jammu; 180 mm SL. 3. Head of the above (from river Tawi) enlarged.





Species of mahseer: 1. *Tor progeneius* (McCell.) from Barak river, Karong, Assam, 270 mm SL.
2. Head of the above,

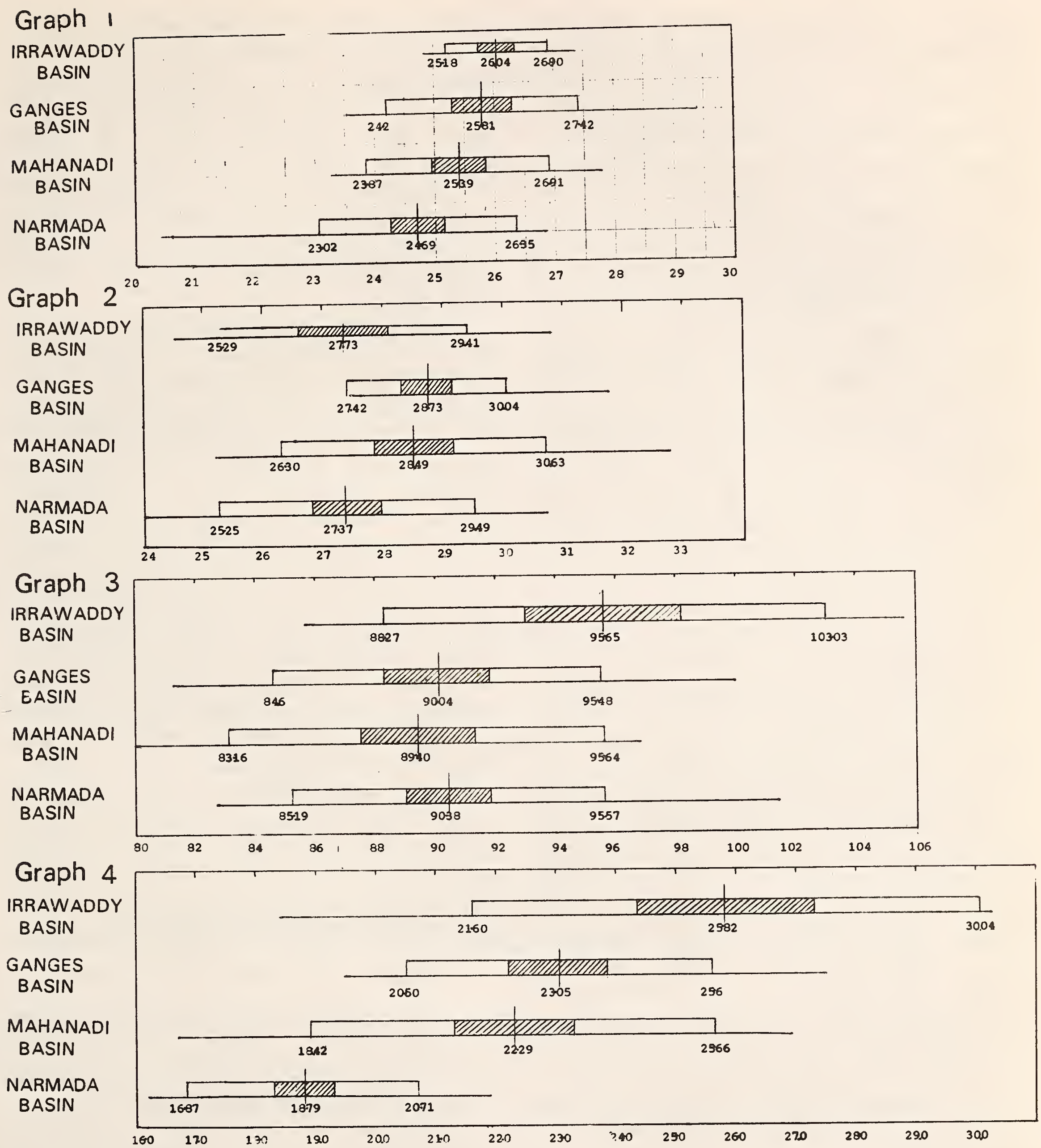


Fig. 1. *Tor tor* (Ham.)
Variation within samples from different drainages: Irrawaddy, Ganges, Mahanadi and Narmada.
Graph 1. Head length in SL, in per cent; Graph 2. Body depth in SL, in per cent; Graph 3. Head length in Body depth, in per cent; Graph 4. Eye diameter in Head length, in per cent.

of *Barbus (Tor) progeneius*, the large-scaled barbel described by McClelland from Assam. He observed that "in *tor* the head is more pointed and the body is considerably deeper and more pronounced along the ventral surface, while in *progeneius* the head is evenly pointed and is more or less equal to the depth of the body which is slender and graceful. *B. progeneius* in its general facies is similar to *B. mosal* and it is likely that when more material of the two forms becomes available they may prove to be identical." He further observed that in *B. progeneius* there is a rounded, fan-shaped structure behind the upper lip which in form and extent is quite different from the hypertrophied lip of *B. putitora* and *B. tor.* For this reason he considered *progeneius* as a distinct species. I have examined in the collections of the Z.S.I. several specimens of *Tor progeneius* from the Barak river, Assam, which has enabled me to establish its specific identity. The rounded fan-shaped structure that Hora noticed in one specimen has been proved to be an abnormal condition, as such a structure has not been observed in any other specimen in the collections of the Z.S.I.

On the strength of the investigations conducted by Dr. M. Suter, at the type-locality of *Barbus mussullah* Sykes and having been convinced that Sykes' *Barbus mussullah* is a species of *Tor,* Hora (1943) reassigned *Barbus mussullah* Sykes to *Tor* though it is now established that *Barbus mussullah* is not a *Tor* but belongs to the genus *Hypselobarbus* (Rainboth, 1989). Hora's *Barbus (Tor) mussullah* Sykes is synonymised here with *T. khudree* (Sykes). In captive environment and in reservoirs abnormal deep-bodied forms of *khudree* are sometimes met with. The series of indistinct tubercles on the sides of the head below the eyes in males and the length of head (3.5 in SL) of such abnormal forms of *T. khudree* immediately reveal their identity.

Hora (1943) also a redescribed *Barbus (Tor) khudree* Sykes based on a female specimen collected by Dr. Rishworth in the Ulhas river about 40 miles north of Bombay flowing into the Arabian sea from the western slopes of the Ghats. He described the colour as: "silvery bluish grey below the middle line, and almost creamy yellowish white on the ventral surface. The colour is darker above the lateral line, the bases of the scales being grey and their margins reddish grey. The colour of the back is dark olive. The head is dark olive above, and creamy yellowish white below. The fins are bluish grey."

Later Hora (1943a) dealt with the specific identity of Jerdon's species of mahseers from southern India. Excluding those with a serrated dorsal spine, and scales along lateral line numbering more than 30, and with labial folds interrupted, Hora considered five species as mahseers from Jerdon's list of 14 species of *Barbus.* These are *B. hamiltonii, B. megalepis, B. malabaricus, B. mussullah* and *B. khudree.* After a careful study of Jerdon's species Hora concluded that of the five species of *Tor*-type included by Jerdon there are only two types: (1) *Barbus khudree* Sykes (= *B. hamiltonii* nec. Gray and *B. malabaricus* Jerdon) and (2) *B. mussullah* Sykes (= *Barbus megalepis* Jerdon nec. McClelland), distributed widely in the principal rivers of the peninsula.

Shaw and Shebbeare (1929), Shebbeare (1930, 1931), McDonald (1929, 1933), Van Inger (1937) and Parson (1943) recognised several varieties of mahseer based on colouration, which is a highly variable character due to environmental factors (*vide* Hora 1941, p.804).

Morphometric and Meristic Characters

The following morphometric and meristic characters of the samples of the different populations occurring in the major river basins of India including Burma were studied.

Morphometric characters: 1. Length of head (in Standard length); 2. Depth of body (in Standard length); 3. Length of snout (in length of head); 4. Width of head (in length of head); 5. Depth of head (in length of head);

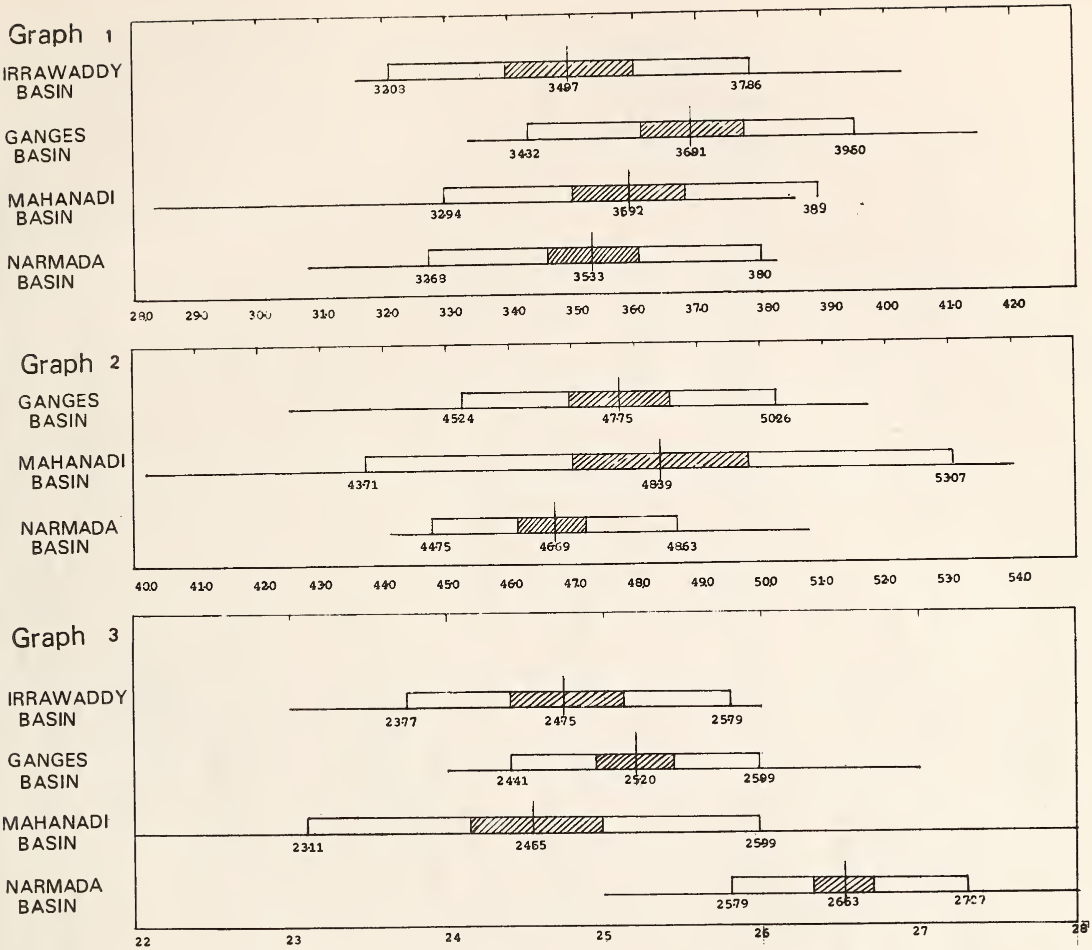


Fig. 2. *Tor tor* (Ham.)
Variation within samples from different drainages; Irrawaddy, Ganges, Mahanadi and Narmada.
Graph 1. Percentage of snout length in head length; Graph 2. Percentage of post-orbital length in head length;
Graph 3. Lateral line scales.

6. Diameter of eye (in length of head); 7. Inter-orbital width (in length of head); 8. Depth of caudal peduncle (in length of caudal peduncle).

Meristic characters: 9. Scales along lateral line; 10. Scale rows between lateral line and base of pelvic fin.

Biometric Comparison of Populations

For a correct taxonomic assessment of the samples, the range, mean, standard deviation and standard error were calculated for the characters considered important in species differentiation and presented in graph form (Figs. 1-4). For each sample the diagrams show: (1) total range of variation of the particular character indicated by the horizontal line, (2) the mean, by the vertical line indicated in the middle of it, (3) the standard error by the blackened area of each bar and (4) the standard deviation indicated by one half of each black bar plus the white bar at

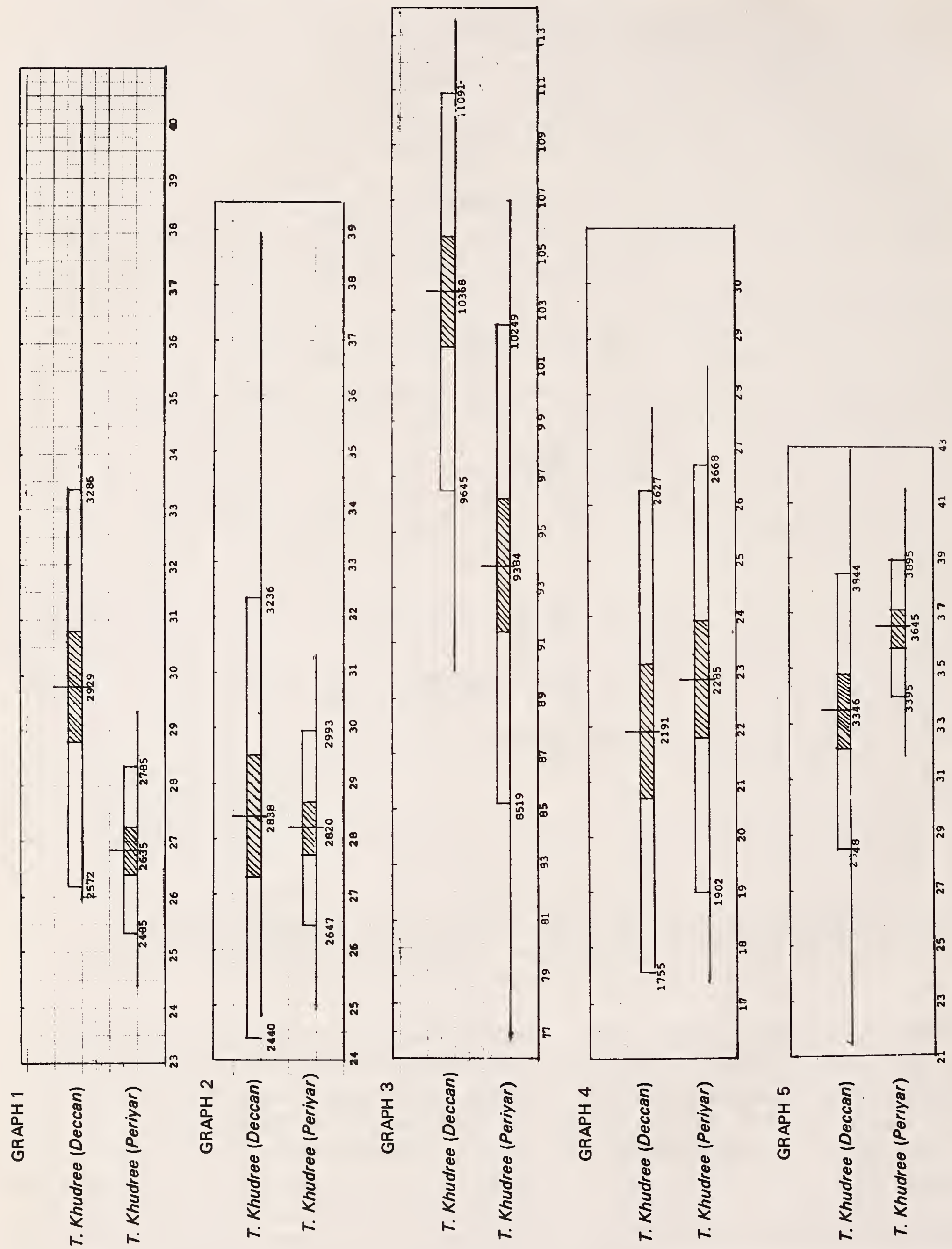


Fig. 3. ***T. khudree*** **from the Deccan and the Cauvery compared with the population of *T. khudree* from the Periyar river draining Western Ghats into the Arabian sea.**

Graph 1. Percentage of head length in SL, Graph 2. Percentage of body depth in SL; Graph 3. Percentage of head length in Body depth; Graph 4. Percentage of eye diameter in head length; Graph 5. Percentage of snout length in head length.

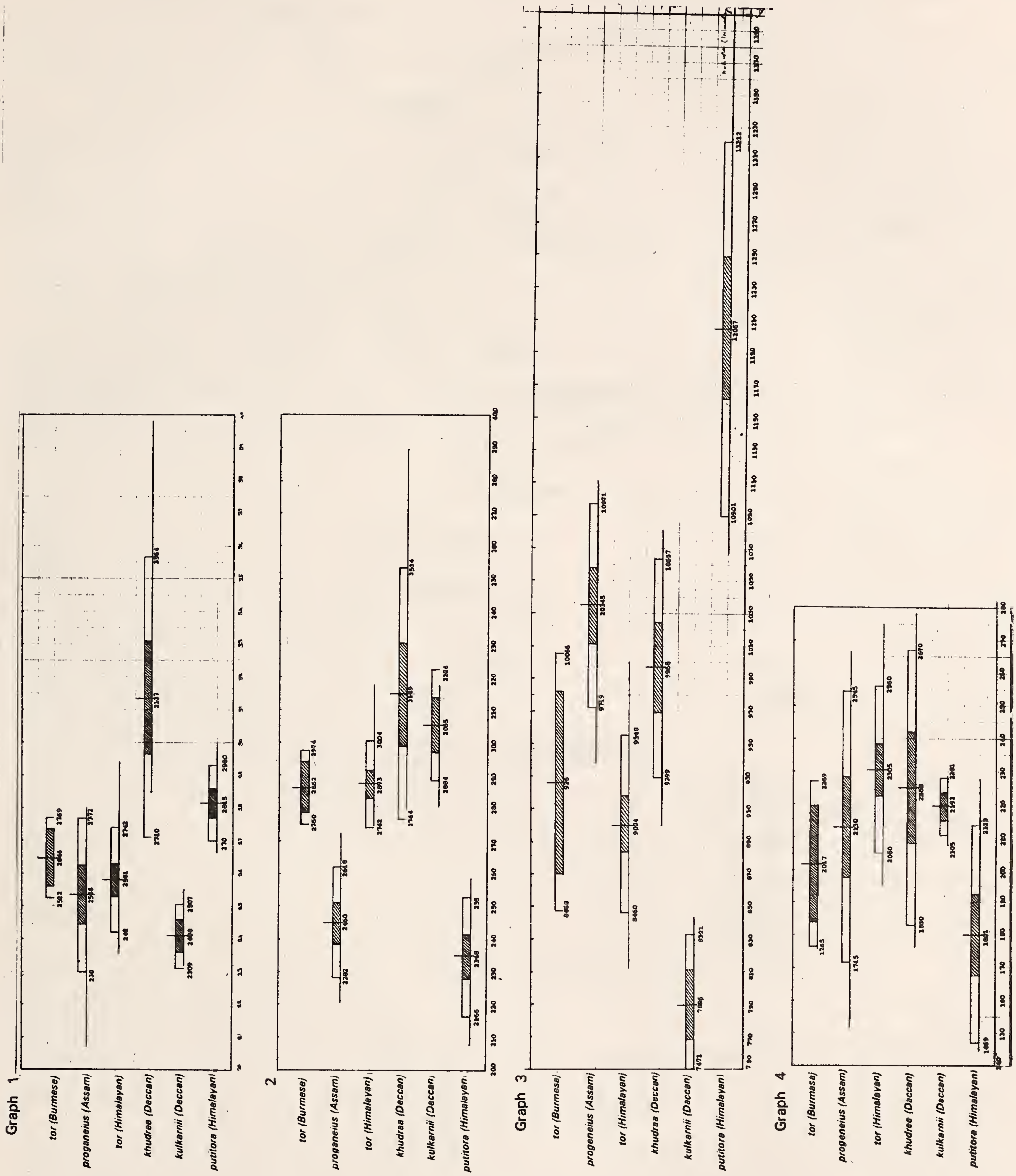


Fig. 4. Variations among different species of *Tor* Gray.
Graph 1. Head length in SL, in per cent; Graph 2. Body depth in SL, in per cent; Graph 3. Head length in body depth, in per cent; graph 4. Eye diameter in head length, in per cent.

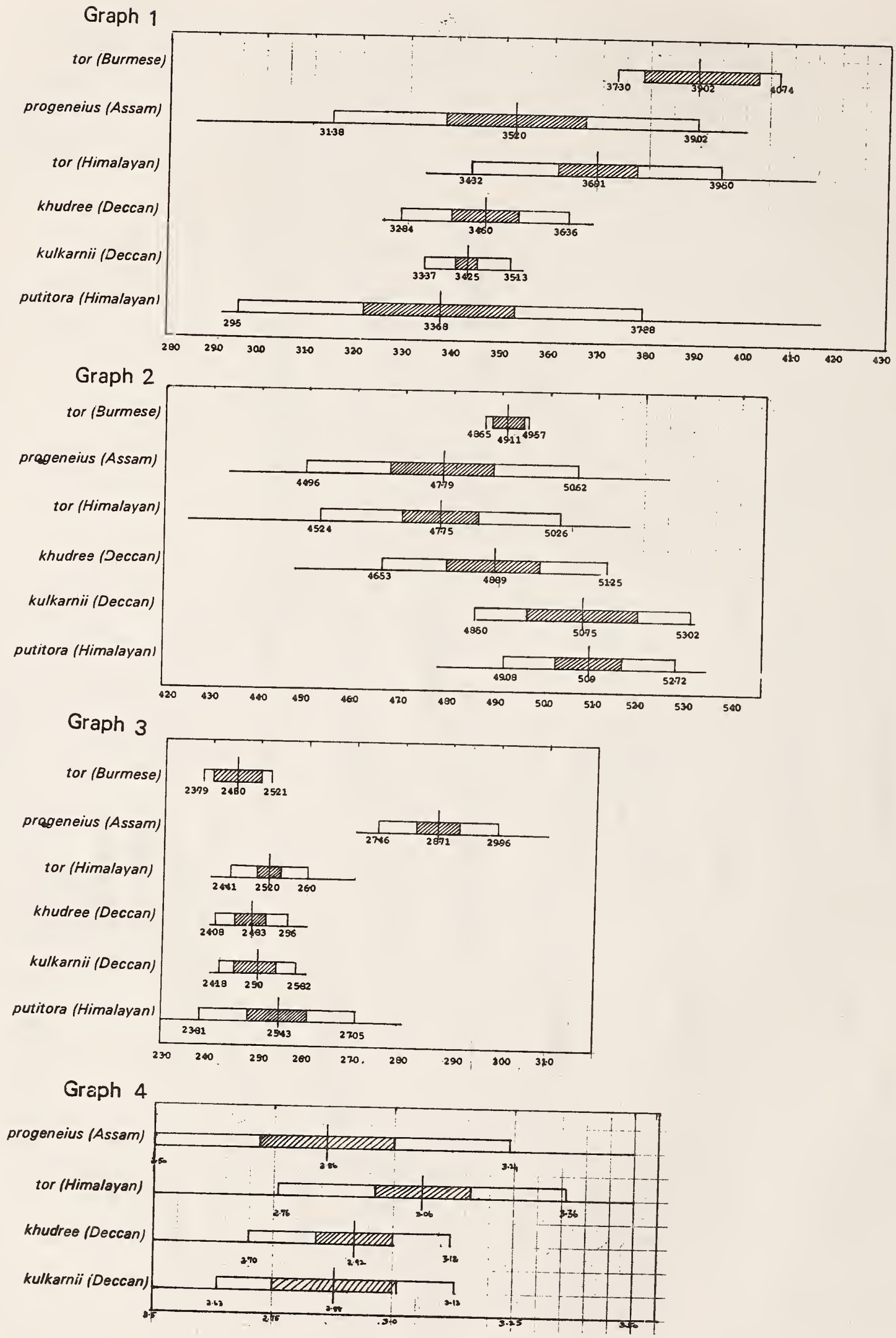


Fig. 5. Variations among different species of *Tor* Gray.
Graph 1. Snout length in head length, in per cent; Graph 2. Post orbital length in head length, in per cent; Graph 3. Lateral line scales; Graph 4. Scale rows between lateral line and base of pelvic.

either end. The degree overlap or divergence of the standard deviations of the characters studied has been taken to determine the status of the populations (vide Hubbs and Hubbs 1953).

The intergradation of characters of *T. tor* populations from the drainages, viz. Irrawaddy, Brahmaputra, Ganges, Mahanadi and Narmada (Fig. 1, Graphs 1-4; Fig. 2, Graphs 1-3) make it evident that these populations are identical and are, therefore, considered as belonging to the same species, *T. tor* (Ham.).

The populations of the Krishna, Godavari, and the Cauvery which are considered as *T. khudree* (Sykes) are pooled together and compared with the populations of the west-flowing rivers of the Western Ghats of Kerala (Fig. 2). It is evident from the overlap of the standard deviation of all the characters tested that they are the same. The Kerala population of *T. khudree* is therefore not considered different from that of the Deccan and the Mysore plateau.

The characters by which the various species of *Tor, T. tor, T. putitora, T. khudree, T. progeneius* and the new species, *T. kulkarnii* can be easily separated aie represented in Fig. 4, graphs 1-4; Fig. 5, graphs 1-4.

The length of the head in proportion to the depth of the body is considered the most important character in distinguishing the mahseer species occurring in India. This ratio is a measure of the efficiency of the fish to withstand the fast flowing current, the fish becoming more streamlined. Employing this character randomly, however, has often led to difficulty in separating the species. Often in a population of *Tor tor*, specimens somewhat similar to *T. putitora* will be seen. Probably it was because of this overlapping that Day treated *Tor tor, T. putitora* and *T. mosal* as a single species. A careful statistical analysis of the populations of the different species has, however, convinced me that the judicious use of the character of head length/body depth ratio is the best method to separate the species. *Tor tor, T. putitora, T. progeneius, T. khudree* and *T. kulkarnii* sp. nov. are the five valid species occurring in India. *T. mosal* is treated in this paper as a junior synonym of *T. tor*.

The length of the head is considerably greater than the depth of body in *T. putitora* (see Fig. 3, graph 3) whereas the length of the head is considerably shorter or more or less equal to the depth of the body in the other species. The length of head is somewhat equal to the depth of body in *T. khudree,* whereas it is shorter in the case of *T. tor* and *T. kulkarnii. T. kulkarnii* can, however, be easily separated by its considerably short head (length of head 4.1, 3.8 in *T.tor*, 3.2 in *T. khudree*) (Fig. 4, graph 1). *T. progeneius* has an increased number of scales along the lateral line (Fig. 5, graph 3).

Genus *Tor* Gray

Tor Gray, *Illust. Indian Zool.,* 2:96, 1830-34 (Type species: *Cyprinus tor* Hamilton = *Tor hamiltoni* Gray, haplotype)

Labeobarbus Ruppell, *Mus. Senckenberg,* 2:14, 1936

Barbus (Tor) Hora, *J. Bombay nat. Hist. Soc.*, 41(2):276, 1939

Tor Smith, *Bull. U.S. Nat. Mus.*, No. 188:137, 1945.

Diagnostic features: Medium to large size, body elongate, moderately compressed. Snout more or less prominent, mouth slightly inferior, horseshoe shaped, upper jaw strongly protractile. Lips thick, continuous, lower with an uninterrupted posterior fold, with or without a median lobe on the lower lip. Long maxillary and rostral pairs of barbels.

Dorsal fin with nine branched rays, its origin somewhat anterior to or in line with, the origin of ventrals; last osseous ray elongate, smooth, and non-denticulated. Anal with five branched rays. Scales large, lateral line complete with 24-30 scales. 10-16 (8-10 in *progeneius)* long, slender gill rakers on 1st ceratobranchial. Pharyngeal teeth in three rows, 5.3.2-2.3.5.

Size: Specimens of 150 to 247 cm in length and weighing about 60 kg are reported,

45 cm and 2 to 5 kg are more common.

Distribution: Asiatic mainland and the Indo-Australian Archipelago.

KEY TO SPECIES OF THE GENUS *Tor* GRAY

1. L.l scales less than 27 (24-27) 2
   L.l scales more than 27 (27-30) ... *T. progeneius* McClell. (Brahmaputra drainage, Assam)
2. Length of head considerably greater than depth of body, length of head less than 4 (3.5) times in S.L. .... *T. putitora* (Slender bodied Himalayan mahseer, all along the Himalayas)
   – Length of head equal to or considerably shorter than depth of body 3
3. Length of head equal to depth of body (rarely shorter); length of head about 3.5 (3.2) in S.L., sides of head below eye with series of indistinct tubercles in males .... *T. khudree* (Peninsular India, south of Vindhyas)
   – Length of head shorter than depth of body. Length of head more than 3.5 in S.L., sides of head smooth without tubercles 4
4. Length of head about 4 (3.8) times in S.L. .... *T. tor* (Deep bodied Himalayan mahseer; all along the foot hills of the Himalayas and the Vindhya-Satpuras)
   – Length of head more than 4 (4.17) times in S.L. .... *T. kulkarnii* (Godavari drainage, Deccan)

Tor khudree (Sykes)

Barbus khudree Sykes, *Proc. Zool. Soc. Lond.*, p.159, 1838 (Mula-Mutha river, 8 miles east of Poona). Sykes, *Trans. Zool. Soc.* 2:357, 1841 (Mula-Mutha river, 8 miles east of Poona). Jerdon, *Madras J. Lit. & Sci.* 15:313, 1849. Bleeker, *Verk. Bat. Gen.*, 25:60, 1853. Hora & Misra, *J. Bombay nat. Hist. Soc.* 40(1):24, 1938 (Deolali). Hora, *J. Bombay nat. Hist. Soc.*, 43(2):167, 1942 (colour, sex differences, weight up to 50 lbs, Mula-Mutha, Poona).

Barbus hamiltonii (nec Gray), Jerdon, *Madras J. Lit. & Sci.*, 15:311, 312, 1849.

Barbus malabaricus Jerdon, *Madr. J. Lit. & Sci.*, 5:312, 1849 (Mountain streams of Malabar). Day, *Fish India* 569, pl. 138, fig. 3, 1878 (South Canara down the Western Ghats to Travancore hills). Day, *Faun. Brit. Ind. Fish.* 1:314, 1889 (South Canara down the Western ghats to Travancore hills).

Barbus megalepis, Jerdon (nec McClell.), *Madras Journ. Lit. & Sci.* 15:311, 1849.

Barbus neilli Day, Proc. Zool. Soc. Lond., p. 581, 1868 (Thungabhadra river at Kurnool). Beavan, *Handbook FW. Fish Ind.*, p. 45, 1877 (Tambodra R.). Day, *Fish India,* 569, pl. 140, fig. 4, 1878 (Tamboodra river, Karnool). Day, *Faun. Brit. Ind. Fish.,* 1:314, 1889 (Karnool on Thungabhadra river).

Barbus longispinis Gunther, *Cat. Fish. Brit Mus.*, 7:132, 1868 (Ceylon).

Barbus (Tor) khudree, Hora & Misra, *J. Bombay nat. Hist. Soc.* 40:24, 1938 (Mysore). Hora, *Rec. Indian Mus.* 44(2):195, 1942 (Mysore). Hora, *J. Bombay nat. Hist. Soc.* 44(1): 6, 1943 (Ulhas, Cis-Ghat area, north of Bombay).

Barbus mussullah, Spence & Prater (nec Sykes), *J. Bombay nat. Hist. Soc.* 36:472, 1932 (upper Krishna, near Satara). Hora, (nec Sykes), *J. Bombay nat. Hist. Soc.* 43(2): 164, 1943 (Systematics, Krishna river).

Barbus (Tor) mussullah, Hora (nec Sykes), *J. Bombay nat. Hist. Soc.,* 44(1): 5, 1943 (Description; Cauvery & Bhavani rivers).

Barbus (Tor) khudree malabaricus, MacDonald, *J. Bombay nat. Hist. Soc.* 44(3): 52, 1944 (South Canara, W. Ghats, Travancore Hills).

Tor khudree Rajan, *J. Bombay nat. Hist. Soc.* 53(1): 45, 1955 (Bhavani R.). Misra, (in part), *Rec. Ind. Mus.,* 57(1-4): 149, 1959 (U.P., Orissa and Peninsular India., Orissa and U.P. excluded). David, *Proc. nat. Acad. Sci.,* 33B(2): 280, 1963 (Krishna & Godavari rivers). Kulkarni, *J. Bombay nat. Hist. Soc.* 75(3): 652, 1979 (Bhima, Krishna, Koyna & Indrayani rivers in Maharashtra). Sen & Jayaram, *Rec. Zool. Surv. Ind., Occ. Pap.* 39: 7, 1982 (Peninsular India, south of R. Tapti). Jayaram (in part), *Rec. Zool. Surv. Ind., Occ. Pap.* 36: 71, 1982 (Cauvery R.).

Puntius (Tor) khudree, Kalawar & Kelkar, *J. Bombay nat. Hist. Soc.,* 53: 672, 1955 (Kolhapur).

Tor khudree malabaricus, Kulkarni, *J. Bombay nat. Hist. Soc.* 75(3): 652, 1978. Sen & Jayaram, *Rec. Zool. Surv. Ind., occ. Pap.* 39: 13, 1981 (South Canara, Western Ghats, Travancore hills).

Tor mussullah (nec Sykes), Misra, *Rec. Indian Mus.,* 57(1-4): 149, 1959. Kulkarni, *J. Bombay nat. Hist. Soc.* 75(3): 652, 1979 (systematic). Jarayam, *Handbook F.W. Fish. India,* p. 124, 1981 (Cauvery, Bhavani and Poona). Jayaram, *Rec. Zool. Surv. Ind. Occ. Pap.* 36: 72, (Cauvery R.)

Vernacular name: Khudchee, Barsa (in Pune).

Common English name: Deccan mahseer.

Diagnostic features: A streamlined mahseer with the head length almost equal to depth of body; lateral sides of snout with a series of in-

distinct small tubercles in males; back and sides above the lateral line dark in colour, yellowish white below with bluish grey on belly; fins bluish grey.

Description: Based on six specimens, 63.0 mm to 175.0 mm S.L. from Krishna river, Satara dist., Maharashtra (4), Day's specimens from Deccan (2).

D. IV, 9., P. 14-16., A. III, 5., C. 19., L.l. 24-26, L. tr. $4^1/_2/2^1/_2$–$3^1/_2$

Body elongate, streamlined with the upper profile convex before dorsal fin but slightly concave behind it, lower profile slightly arched. Mouth moderate, sloping downwards posteriorly, its gape does not extend to below eye. Lips fleshy, smooth edged, continuous at the angles of mouth with uninterrupted fold or groove along lower jaw, lower lip with a median lobe of varying length (lips hypertrophied in specimens living in highly torrential habitats). Head sharpish, its length equal to depth of body, it is contained 28.48-39.79 (31.37) per cent of S.L.; its depth 60.0-68.89 (65.26) per cent and its breadth 50.0-62.22 (54.78) per cent of head. Snout pointed; its length contained 32.5-36.84 (34.60) per cent of head; the lateral sides of snout covered with a patch of indistinct small tubercles in males. Nostrils nearer to eye than to tip of snout. Eye dorso-ventral, in the anterior half of head, its size highly variable with size of fish, in smaller specimens it is greater; its diameter 17.65-27.78 (22.50) per cent of head, 52.94-84.62 (65.43) per cent of snout, 50.0-84.62 (67.30) per cent of interorbital width. Two pairs of barbels, maxillary barbels longer than diameter of eye reaching beyond posterior margin of eye, rostral shorter than maxillary, reaching anterior border of eye. Body depth greater than its breadth, 27.97-38.93 (31.49) per cent of S.L.

Fins: Dorsal fin almost in the middle of body with its upper margin concave, its last undivided ray modified into a strong, smooth spine, shorter than depth of body below it. Pectoral fin shorter than head; its length 60.0-70.0 (65.11) per cent of head. Pelvics shorter than pectorals, do not extend to base of anal. Anal longer than pelvics, rounded near the tip in female, not reaching the base of caudal. Distance between pectoral and pelvics equal to the distance between pelvic and anal fins. Caudal forked, the lower lobe slightly longer than the upper. Caudal peduncle long and narrow, its least height 64.0-77.27 (71.41) per cent of its own length.

Scales: L.l. 24-26; $2^1/_2$-$3^1/_2$ rows between L.l. and base of pelvic fin, $4^1/_2$ rows between L.l. and base of dorsal fin; 9-10 scales before dorsal fin and 10 rows around caudal peduncle.

Maximum size: About a metre in length and known to attain a maximum of 22.6 kg. in weight. But fish attaining more than half a metre are not caught these days.

Colouration: Colour varies with the habitat in which the fish lives. Usually the sides above lateral line and the back are dark, the sides below lateral line creamy yellowish white and silver bluish grey below on the belly. The bases of scales grey with reddish grey tinged margins. Head dark olive and yellowish white below. Fins bluish grey. Black mahseers are known from Mysore.

Distribution: Deccan (Krishna and Godavari drainages) and peninsular India (Cauvery and the west flowing rivers of Kerala, Karnataka and Maharashtra).

Material examined: MAHARASHTRA: 3 specimens from Lonavla, SRS/ZSI, Madras. 6 specimens, Krishna river, Satara dist., ZSI, Calcutta. 2 specimens from Deccan (Day's specimens), ZSI, Calcutta. TAMIL NADU: 2 specimens from Beligunda (Cauvery river), SRS/ZSI, Madras. MADHYA PRADESH: 1 specimen, Ponch reservoir (Godavari drainage), SRS/ZSI, Madras. KERALA: 2 specimens, Thannikudy (Periyar river), SRS/ZSI, Madras. 2 specimens, Bhutathankettu Dam, 19 km from Kothamangalam, SRS/ZSI, Madras. 2 specimens, Kallada River near Kuluthupuzha, Quilon dist., SRS/ZSI, Madras.

Tor kulkarnii sp. nov.

Diagnostic features: Distinguished from other mahseer fishes by its deeper body and with a short head considerably shorter than the depth of the body, 24-26 scales along lateral line and $2^1/_2$ rows below it to base of pelvic fin.

Description: D. IV, 9, P. 14-16, A. III, 5, C. 19, L.l. 24-26, L.tr. $3^1/_2/2^1/_2$

Body elongate, compressed, compression more towards tail. Upper profile convex before dorsal fin but slightly concave behind it, ventral profile gently arched. Mouth moderate, terminal, sloping downwards posteriorly, its gape not extending to below eye. Lips fleshy, smooth edged, continuous at the angles of mouth with uninterrupted fold or groove along lower jaw. Head sharpish, oval, flattish above; its length considerably shorter than depth of body, it is contained 23.2-25.48 (24.08) per cent of S.L., its depth 71.43-76.04 (74.63) and its breadth 60.0-75.0 (66.69) per cent of head. Snout pointed; its length contained 33.33-35.42 (34.25) per cent of head. Nostrils nearer to eye than to tip of snout. Eye dorso-ventral, in the anterior half of head, its diameter 20.75-22.86 (21.93) per cent of head, 61.11-66.67 (64.05) per cent of snout, 52.5-64.0 (57.88) per cent of interorbital width. Two pairs of barbels, maxillary barbels longer, reaching beyond posterior margin of eye, body depth greater than its breadth, 28.04-31.73 (30.55) per cent of S.L.

Fins: Dorsal fin almost in the middle of body with its upper margin concave, its last undivided ray modified into a strong, smooth spine. Pectoral fin shorter than head; its length 68.75-81.13 (74.93) per cent of head. Pelvics not extending to base of anal. Anal longer than pelvics, smaller than pectoral fin, not reaching the base of caudal. Distance between pectorals and pelvics equal to the distance between pelvic and anal fins. Caudal forked, the lower lobe slightly longer than the upper. Caudal peduncle long and narrow, its least depth 60.0-76.47 (69.15) per cent in its own length.

Scales: L.l. 24-26 (25); $2^1/_2$ rows between L.l. and base of pelvic fin, $3^1/_2$ rows between L.l. and base of dorsal fin, 10-11 scales before dorsal fin.

Maximum size: 208.0 mm S.L.

Colouration: In preserved specimens, body above lateral line is greyish, becoming deeper towards dorsal side, lower parts of head and body silvery. The bases of scales bear dark blotches.

Holotype: ZSI No. FF 2710., Darna river, Deolali, Maharashtra state, 208.0 mm S.L., A.G.L. Fraser, 29 April 1936.

Paratype: 3 specimens, ZSI No. FF 2711, 148.0 to 200.0 mm S.L., in Zoological Survey of India, Calcutta, taken along with the holotype, bearing the same data as the holotype.

Relationships: *T. kulkarnii* is a dwarf cognate of *T. khudree*. The small head and the deeper body distinguish this from all other species of mahseer.

Tor progeneius (McClelland)

Barbus progeneius McClelland, *Asiat. Res.* 19: 270, 334, pl. 56, fig. 3, 1839 (Assam). Hora, *Rec. Indian Mus.*, 38: 328, figs. 7-9, 1936 (R. Barak, between Nongba and Kalanaga, Naga Hills).

Barbus (Tor) progeneius, Hora, *J. Bombay nat. Hist. Soc.*, 42: 526, pl. and tex- figs. 1-3, 1942 (Assam)..

Tor progeneius, Sen & Jayaram, *Rec. Zool. Surv. Ind. occ. Pap.* 39: 11, 1982 (North-eastern Himalayas in Assam, Naga Hills and Manipur: Manipur excluded).

Vernacular name: Jungha in Assamese.

Diagnostic features: A graceful streamlined mahseer with the length of head almost equal to depth of body; and scales along lateral line 27 to 31 rows.

Description: Based on seven specimens, 100 to 290 mm S.L., from Barak river, Karong (6), Ward Lake, Shillong, Meghalaya (1).

D. IV, 9., P. 14-16, A. III, 5., C. 19., L.l. 27-31, L. tr. $4^1/_2$ / $2^1/_2$

Body elongate, muscular and somewhat compressed towards tail, both profiles gently arched, forming a long fusiform body. Mouth moderate, its gape does not extend to below eye and somewhat obliquely directed upwards. Lips

fleshy, smooth edged, continuous at the angles of mouth with uninterrupted fold or groove along lower jaw; lower lip with a median lobe. Head sharpish in front, its length equal to depth of body, it is contained 20.69-28.0 (25.36) per cent of S.L.; its height 63.33-72.0 (66.78) per cent and its breadth 53.33-66.67 (59.05) per cent of head. Snout pointed; its length contained 28.57-40.0 (35.20) per cent of head, the lateral sides of snout covered with a series of tubercles. Nostrils nearer to eye than to tip of snout. Eye dorso-ventral, in the anterior half of head, its size highly variable with size of fish; in smaller specimens it is greater than in larger specimens; its diameter 15.15-26.67 (21.30) per cent of head, 45.0-69.77 (53.29) per cent of snout, 40.82-80.0 (62.80) per cent of interorbital width. Two pairs of barbels, maxillary barbels longer. Body depth greater than its breadth, 22.07-27.20 (24.50) per cent of S.L.

Fins: Dorsal fin almost in the middle of body with its upper margin concave, the dorsal spine weak, the longest ray somewhat equal to depth of body in young specimens but in adult specimens it is shorter. Pectoral fin shorter than head; its length 73.0- 86.0 (78.70) per cent of head. Pelvics shorter, not extending to anal. Anal longer than pelvics, rounded near the tip, not reaching the base of caudal. Distance between pectorals and pelvics equal to the distance between pelvic and anal fins. Caudal deeply forked with both lobes pointed. Caudal peduncle long and narrow, its least depth 41.67-68.18 (56.98) per cent in its own length.

Scales: L.l. 27-31, $2^1/_2$-$3^1/_2$ rows between L.l. and base of pelvic fin, $4^1/_2$ rows between L.l. and base of dorsal fin, 10-12 scales before dorsal fin.

Maximum size: 690 mm (540 mm S.L.).

Colouration: In preserved specimens, body above lateral line is greyish, becoming deeper towards dorsal side, lower parts of head and body silvery. The bases of scales bear dark blotches which are more prominent along dorsal surface.

Distribution: Nagaland and Meghalaya (Brahmaputra system).

Material examined: INDIA: Nagaland: Barak river (Brahmaputra drainage), ZSI, Calcutta. Meghalaya (Brahmaputra system), ZSI, Calcutta.

The fan-shaped structure behind the upper jaw described by earlier workers is an abnormal formation and none of the specimens examined by me has such a structure.

Tor putitora (Hamilton)

Cyprinus putitora Hamilton, *Fish. Ganges,* pp. 303, 388, 1822 (Type locality Eastern parts of Bengal). Hora, *Mem. Ind. Mus.*, 9(4): 178, 1929.

Cyprinus mosal Hamilton, *Fish. Ganges, pp.* 306, 388, 1822 (R. Kosi). Gray, *Ill. Ind. Zool.,* 1, pl. 39, fig. 1 (from Hamilton's MS. drawings) 1830-32.

Labeobarbus macrolepis Heckel, *Fish. Caschmir*, p. 60, pl. 10, fig. 2, 1838 (Kashmir).

Barbus macrocephalus McClelland, *Asiat. Res.*, 19: 270, 335, pl. 55, fig. 2, 1829 (Rapid rivers of Assam). Valenciennes (in C.V.), *Hist. Nat. Poiss.*, 16: 204, 1842. Gunther, *Cat. Fish. Brit. Mus.*, 7: 131, 1868 (Assam).

Barbus mosal, Gunther (in part), *Cat. Fish. Brit. Mus.*, 7: 130, 1868 (Mountain streams of south of Himalayas and Hindukush).

Barbus tor, Day (in part), *Fish. India,* p. 564, pl. 136, fig. 5, pl. 140, fig. 1, 1878. Day (in part), *Faun. Brit. Ind. Fish.*, 1:307, fig. 307, 1889.

Barbus putitora, Annandale, *Rec. Ind. Mus.*, 16: 136, pl. 3, fig. 15, 1919 (Gauhati, Assam). Hora and Mukerji, *Rec. Ind. Mus.*, 38: 141, 1936 (E. Doon). Hora, *Rec. Ind. Mus.,* 38: 366, 1936. Shaw and Shebbeare, *J. Asiat. Soc. Beng.*, 3: 39, fig. 35, 1937. Hora, *Rec. Ind. Mus.*, 39:44, 1937 (Nepal). De Witt, *Stanford Ichth. Bull.*, 7(4): 73, 1960 (Pokhara, Nepal).

Barbus (Tor) putitora, Hora, *J. Bombay nat. Hist. Soc.*, 41(2): 272, 2 pls. and 2 figs., 1939 (systematic position). Menon, *Rec. Ind. Mus.*, 47: 233, 1949 (Kokha nullah, Chhatra, E. Nepal). Menon, *J. Bombay nat. Hist. Soc.*, 48: 539, 1948-49 (Kumaon Himalaya).

Tor putitora, Menon, *Rec. Ind. Mus.*, 52: 22, 1954 (Nepal). Misra, *Rec. Ind. Mus.*, 57: 150, 1959. Jayaram, *Handbook F.W. Fish. India,* p. 124, 1981. Shrestha, *Fish. Nepal,* p. 102, 1981. Sen and Jayaram, *Rec. Zool. Surv. India, occ. Pap.* 39: 5, 1982.

Tor (Tor) putitora, Mirza & Javed, *Biologia, Special Suppliment,* p. 76, 1986 (Bajwat, Head Marala, R. Haro, Sun Sakesar, Mangla Lake, Tarbela Lake and Azad

Kashmir.)

Vernacular name: Putitora in Goalpara, Sahara and Turyia in Purnea, Tor in Rangpur, Mahsir in Punjab, Jammu & Kashmir.

Common English name: Yellow-fin mahseer.

Diagnostic features: An oblong, somewhat compressed, streamlined mahseer, the head broadly pointed anteriorly, the length of the head always considerably greater than the depth of body. Back reddish sap-green in colour, generally with a broad purplish band above the lateral line, below the lateral line the body is orange fading into silvery white on the belly, paired fins yellowish.

Description: Based on 7 specimens, 116.0 to 320.0 mm from Namdapha river, Tirap dist., Arunachal Pradesh (1), Day's figured specimen (1), Day's specimen from Assam (1), Nainital (1), Jhelum river, Kashmir (1), Tawi river, Jammu (1), and Salt Range (1).

D. IV, 9-10; P. 14-17; V. 9; A. III, 5; C. 19; L.l. 23-28; L. tr. $4^1/_2$ / $2^1/_2$.

Body muscular, elongate and somewhat compressed, both profiles gently arched forming a long fusiform body. Mouth small, sub-terminal; its gape does not extend to below eye. Lips fleshy, sometimes greatly thickened, smooth edged, continuous at angles of mouth with uninterrupted fold or groove along lower jaw. Lower lip with a median lobe of varying length; in specimens from fast-flowing highly rocky streams it is longer and sometimes co- extensive with extent of mouth, smaller with ordinary lips (not hypertropied) in specimens living in slow moving sandy and pebbly habitats. Head long, broadly pointed anteriorly; its length always greater than depth of body; it is contained 26.67-30.0 (28.15) per cent of S.L., its depth 55.41-63.64 (59.83) per cent, its breadth 43.92-55.56 (49.47) per cent of head, length of snout 29.17-41.67 (33.68) per cent of head. Interorbital width almost equal to or slightly less than snout length, its width 24.32-31.82 (28.01) per cent of head. Eye large, dorso-lateral in position, its diameter 14.44-22.73 (18.01) per cent of head, 36.0-75.0 (54.87) per cent of snout and 50.0-83.33 (64.53) per cent of interorbital width (in smaller specimens eye is larger and more than interorbital width but in smaller specimens it is less). Two pairs of barbels, maxillary barbels longer than diameter of eye, reaching beyond posterior margin of eye, rostral equal to or sometimes shorter. Body depth greater than its breadth 20.78- 25.86 (23.48) per cent of S.L.

Fins: Dorsal fin almost in middle of body with upper margin concave, its last undivided ray forming a strong smooth spine, shorter than depth of body below it, but in some it is equal to body height. Pectoral fin sharp with slight convex edge, considerably shorter than head, its length 58.89-72.22 (65.61) per cent of head. Pelvic horizontal, almost midway between head and caudal base, its origin slightly behind and just under dorsal origin, not reaching anal opening. Distance between pectoral and pelvics almost equal to distance between pelvics and anal fin base. Anal fin equal to or slightly shorter than pectorals, not reaching base of caudal fin. Caudal fin forked with the lower lobe somewhat more pointed. Caudal peduncle long and narrow, its least depth 50.0-71.43 (59.08) per cent of its own length.

Scales: L.l. 23-28; $2^1/_2$ rows between L.l. and base of pelvic fin, $4^1/_2$ rows between L.l. and base of dorsal fin, 9-11 scales before dorsal fin and 11-12 rows around caudal peduncle.

Maximum size: 2.7 metres. Hora (op. cit.) recorded specimens of 60 cm (2 feet). According to Thomas (op. cit.) 18 to 25 kg fish were common in India but these days fish more than 5 kg are rarely caught.

Colouration: Hamilton (loc. cit, p. 6) noted the colour as dusky above with a gloss of steel, while the edges of scales changed from gold to silver. Fins tinged yellowish. According to Hora (1939) the colour varies according to the nature of water inhabited by the fish. The back is reddish sap-green. Below the lateral line, the body is light orange fading to silvery white on belly. In specimens about 30 cm the dorsal fin is

light yellowish with the rays conspicuously yellowish grey, pectorals pinkish at base with citron yellow distally; pelvic, anal and caudal fins yellowish with pink extremities. In larger specimens the pelvic, pectoral and caudal fins are peacock green. In specimens collected from torrential rivers the paired fins are generally pale in colour.

Distribution: INDIA: All along the base of the Himalayas including Kashmir; Pakistan, Bangladesh.

Material examined: INDIA: Arunachal Pradesh: 1 specimen, ZSI, Calcutta; Assam: 2 specimens, ZSI, Calcutta; U.P.: 1 specimen, ZSI, Calcutta; Jammu & Kashmir: 2 specimens, ZSI, Calcutta; Punjab: 1 specimen, ZSI, Calcutta.

Tor tor (Ham.)

Cyprinus tor Hamilton, *Fish. Ganges,* pp. 305, 388, 1822 (R. Mahananda). Gray, *Ill. Ind. Zool.*, 2, pl. 93, fig. 1 (from Hamilton's MS. drawings, 1834).

Barbus megalepis McClelland, *Asiat. Res.*, 19, pp. 271, 337, 1839 (Northern parts of Bengal).

Tor hamiltonii Gray, *Ill. Ind. Zool.*, 2. pl. 36, fig. 1, 1839.

Barbus hexasticus McClelland, *Asiat. Res.*, 19, pp. 269, 333, pl. 39, fig. 2, 1839 (Great rivers in the plains of India). Day (in part) *Fish. India,* p. 565, pl. 136, fig. 4, 1878 (Kashmir, Sikkim and Assam). Day (in part) *Faun. Brit. Ind. Fish*, 1:308, 1889. Hora, *Rec. Indian Mus.*, 22:174, 1921 (Manipur). Prasad & Mukerji, *Rec. Indian Mus.*, 31:200, text-fig. 7, 1929 (Indawgyi Lake, Upper Burma).

Barbus mosal, Valenciennes (in C. V.), *Hist. Nat. Poiss.*, 16:200, 1842. Bleeker, *Verh. Bat. Gen.*, 25:60, 1853. Day, *Proc. Zool. Soc. Lond.*, p. 372, 1870. Gunther (in part), *Cat. Fish. Brit. Mus.*, 7:130, 1868 (Mountain streams of south of Himalayas and Hindukush).

Barbus tor, Day (in part), *Fish. India, p.* 364, 1878. Day (in part) *Faun. Brit. Ind. Fish.*, 1:307, 1889. Hora & Mukerji, *Rec. Indian Mus.*, 37:383, 1935 (Naga Hills). Hora & Mukerji, *Rec. Indian Mus.*, 38:134, 139, fig. 1, 1936 (R. Barak, between Nongba and Kalanaga, Naga Hills). Mukerji, *J. Bombay nat. Hist. Soc.* 37:63, 1984 (Burma).

Tor khudree, Chauhan (nec Sykes), *Rec. Ind. Mus.*, 15:270, 1918 (R. Tel, tributary of the Mahanadi, Orissa). Hora, *J. Zool. Soc. India,* 1, No. 6: 1949 (R. Rihand, U.P.). Motwani & David, *J. Zool. Soc. India,* 9, No. 1:11, 1957 (R. Sona, M.P.)

Barbus (Tor) mosal, Hora, *J. Bombay nat. Hist. Soc.* 41:784, pls. 1 and 2, figs. 1–5, 1941 (Assam).

Barbus (Tor) tor, Hora, *J. Bombay nat. Hist. Soc.*, 41:518, 1941 (systematic position).

Tor tor mosal, Macdonald (nec Ham.), *J. Bombay nat. Hist. Soc.*, 44:189, 1943 (Burma).

Tor mosal mahanadicus David, *J. Zool. Soc. India,* 5, No. 2:246, 1953 (Hirakund stretch, Mahanadi, Orissa).

Tor tor, Menon, *Rec. Indian Mus.*, 52:22, 1954 (Manipur). Motwani & David, *J. Zool. Soc. India,* 9, No. 1:11, 1957 (R. Sona, M.P.). Misra, *Rec. Indian Mus.*, 57:150, 1959. Srivastava, *Fish. Eastern U.P.*, 57, 1968 (Gorakhpur). Jayaram, *Handbook F.W. Fish. India,* p. 124, 1981. Shrestha, *Fish. Nepal.* p. 104, 1981. Sen & Jayaram, *Rec. Zool. Surv. Ind., Occ. Pap.*, 39:9, 1982.

Vernacular name: Tor mahseer.

Common English name: Red-fin mahseer.

Diagnostic features: A more stoutly built mahseer than the putitor, with the ventral profile more prominently arched than the dorsal. Head sharpish anteriorly and is invariably shorter than the depth of the body. Dorsal surface greyish-green, the sides of the body in the middle pinkish replaced with greenish fold above and olive green below. Fins deep orange.

Description: Based on 10 specimens 68.0 to 162.0 mm S.L. from Suswa and Song rivers, Dehra Dun, U.P.

D. IV, 9., p. 14–16., A. III, 5., C 19., L.l. 22–28, L. tr. $3^1/_2$-$4^1/_2$ / $2^1/_2$-$3^1/_2$

Body more stoutly built than the Putitor mahseer, muscular and compressed, with ventral profile more prominently arched than the dorsal, dorsal profile convex before dorsal fin but slightly concave behind it. Mouth small, its gape does not extend to below eye. Lips fleshy, smooth edged, continuous at the angles of mouth with uninterrupted fold or groove along lower jaw, lower lip invariably with a median lobe of varying length. In the Dehra Dun examples, the lips and the median lobe are moderately developed. (Lips hypertrophied in specimens living in torrential streams of Tista river, Darjeeling and Barak river, Assam). Head sharpish anteriorly, and shorter than the depth of body (or equal in young examples), it is con-

tained 23.53–29.41(25.81) per cent of S. L.; its depth 69.23–77.59(73.12) per cent, its breadth 50.0–62.50(57.80) per cent of head. Snout pointed; its length contained 33.33–41.46(36.91) per cent of head. Nostrils nearer to eye than to tip of snout. Eye dorso-ventral, in the anterior half of head, its size highly variable with size of fish, in smaller specimens it is greater than in larger specimens; its diameter 19.51-27.50 (23.05) per cent of head, 47.06–78.57(62.97) per cent of snout, 53.33–91.67(69.47) per cent of interorbital width. Two pairs of well-developed barbels, maxillary barbels slightly longer than the rostral but shorter than diameter of eye. Body depth greater than its breadth 22.46–31.75(28.73) per cent of S.L.

Fins: Dorsal fin almost in the middle of body with its upper margin concave, its last undivided ray strong and bony and is invariably shorter than the depth of body. Pectoral fin slightly shorter than head; its length 62.50–86.21 (73.49) per cent of head. Pelvic fins do not extend to anal opening. Anal longer than pelvics, not reaching the base of caudal. Distance between pectorals and pelvics equal to the distance between pelvic and anal fins. Caudal deeply forked, the lower lobe sharply pointed. Caudal peduncle long and narrow, its least depth 59.38–78.26 (67.82) per cent of its own.

Scales: L.l. 22–28, $2^1/_2$ to $3^1/_2$ rows between L.l. and base of pelvic fin, $3^1/_2$ to $4^1/_2$ rows between L.l, and base of dorsal fin, 11–12 scales before dorsal fin and 11–12 rows around caudal peduncle.

Maximum size: 1.7 metres, weighing 45 kg (Thomas 1897).

Colouration: Hamilton (1822, p. 305) noted the colour as gold and green above, silvery below and the fins of the belly reddish. According to Hora (1940), the dorsal surface is greyish-green, that of head neutral green. The sides of the body in the middle are pinkish, replaced above by greenish gold and below by olive green. The dorsal fin is reddish buff, the pectorals, pelvics and anal fins are deep orange.

Distribution: INDIA: Assam and all along the foothills of the eastern and central Himalayas as far as Jumna system, higher reaches of the Mahanadi in Orissa and the Vindhyas and Satpura ranges, Madhya Pradesh; Bangladesh, Burma.

Material examined: INDIA: Assam: 6 specimens, ZSI, Calcutta, Barak river, Karong. Meghalaya: Shillong, 1 specimen, 290.0 mm S.L., ZSI, Calcutta. Uttar Pradesh: Dehra Dun: 10 specimens, ZSI, Calcutta, Suswa and Song drainages. Orissa: 11 specimens, ZSI, Calcutta. Sundargarh: Brahman river. Madhya Pradesh: Narmada drainage, 14 specimens SRS/ZSI, Madras. BURMA: Kamaing, Myitkyiana Dist., ZSI, Calcutta, 2 specimens.

SUMMARY

The literature relating to systematics of various species of *Tor* is reviewed and it is pointed out that neither melanism and other variations in colour nor the enlargement of the lips usually met with among species of mahseer should be mistaken for specific or racial features. Morphometric data of samples of deep-bodied Himalayan mahseer *Tor tor* (Ham.) from various drainages is biometrically analysed and the results indicate that they belong to the same species. *T. mosal* (Ham.) is synonymised with *T. putitora* (Ham.); *Tor mosal* of Hora (nec. Ham.) is synonymised with *T. tor* (Ham.). The deep bodied mahseer from the peninsula so far confused with *Hypselobarbus mussullah* Sykes is reidentified as an abnormal *T. khudree* (Sykes). A series of tubercles on the sides of the head below the eyes in the males of *khudree* is characteristic of the species, though presence of tubercles in the breeding males is reported in *putitora* mahseers as well; *progeneius* is the only species having a series of tubercles on the lateral sides of snout in both the sexes.

Description of a new mahseer characterised by a short head discovered from the Dharna river (Godavari drainage) at Deolali is also given.

ACKNOWLEDGEMENTS

I am greatly indebted to T.K. Sen, Officer-in-Charge, Fish Division, Zoological Survey of India, Calcutta, for placing the entire mahseer material of the National Zoological Collections at my disposal for this study. My thanks are also due to Dr. G.M. Yazdani, Officer-in-Charge, Western Regional Station, Poona, Prof. K.S. Rao, Department of Zoology, Vikram University, Ujjain, and S.N. Ogale, Environment Officer, Tata Electric Companies, Lonavla, for the additional material of mahseer they provided me for this study.

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NEW DESCRIPTIONS

PUNTIUS MUDUMALAIENSIS, A NEW CYPRINID FISH FROM MUDUMALAI, TAMIL NADU[1]

A. G. K. Menon and K. Rema Devi[2]

(With a text-figure)

A new species of *Puntius* is described from Mudumalai, Western Ghats, which is different from all the other known puntiids with one pair of barbel, a weak dorsal spine and an incomplete lateral line system.

Introduction

From the Mudumalai forests of Western Ghats, small, deep bodied puntiid specimens were collected, which differ from all other two-spotted barbs known so far. Descriptions are based on measurements with dial calipers with an accuracy of 0.02 mm. Data is presented in text as times in SL and HL, with the range followed by the mean in parenthesis and in Table 1, as percentages of SL and HL.

Diagnosis: A small-sized *Puntius* with a proportionately large head, deep body, a pair of maxillary barbels, a weak and articulated dorsal spine, an incomplete lateral line and two blotches (one on dorsal base and another on caudal peduncle) and with a faint lateral band. Lower lip with a fleshy symphysis.

Holotype: Zoological Survey of India, Southern Regional Station, Madras; Reg. No. F. 2755; 20.0 mm SL; Kakkanhalla road, Mudumalai, Tamil Nadu, India; 1180 m; 11 October 1987; Coll. M. Vasanth.

Paratypes: 20 specimens, 14.0-23.5 mm SL, data as above.

Description: D. 3-4/8; P. 13; V. 1/8; A. 3/5; C.1/17/1; L.1.26; L. tr. 5 1/2/ 3 1/2; predorsal scales 9-10. Body deep anteriorly, tapering posteriorly, 3.02-3.57 (3.28) in SL, 1.07-1.26 (1.17) in HL; head large, its length 2.69-2.88 (2.79); width of head 1.78-1.99 (1.90), depth of head 1.34-1.52 (1.39) in HL; eye diameter 3.47- 4.50 (4.03), interorbital 2.78-3.55 (3.09), snout 3.09-3.69 (3.33) in HL; sensory canal pores as about six radiating rows below eye. Mouth small, lips fleshy and folded back enclosing a deep groove, symphysis of lower lip fleshy; gape of mouth 2.54-3.84 (3.44) in HL; one pair of small maxillary barbels reaching to anterior third of eye. Dorsal fin situated midway between snout tip and caudal base, its spine weak and articulated. Predorsal distance 1.75-1.99 (1.88), postdorsal 1.86-2.03 (1.94), prepelvic 1.82-2.01 (1.92), preanal 1.31-1.48 (1.41) in SL; predorsal 0.93-1.03 (0.96) in postdorsal length. Length of dorsal fin 3.32-4.16 (3.69), dorsal base 4.90-5.69 (5.36), length of pectoral 4.94-6.05 (5.56), pelvic 4.76-5.57 (5.17) and anal 4.59-5.65 (5.03) in SL; dorsal fin 1.22-1.46 (1.32), pectoral 1.82- 2.14 (1.98), pelvic 1.65-1.96 (1.85) in HL; caudal peduncle slender, its length 4.71-5.98 (5.34), height 6.82-8.58 (7.51) in SL, in HL it is 1.64-2.12 (1.91) and 2.54-3.04 (2.68) respectively. Height of caudal peduncle 1.26-1.63 (1.40) in its length; length of body cavity (distance from pectoral base to anus) 2.44-2.95 (2.68) in SL. *Gill rakers:* 12 gill rakers in the first gill arch.

Colouration: In formaldehyde, uniform brown with a pale lateral band from behind upper margin of opercle to caudal base; a dark spot on dorsal base from the 3rd to the 5th ray, dorsal margin dark tinged; caudal peduncle with a dark spot; anal fin pigmented

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TABLE 1

MORPHOMETRIC DATA OF *Puntius mudumalaiensis* SP. NOV. (10 SPECIMENS)

	% SL			% HL		
	range	$\overline{X}$	SD	range	$\overline{X}$	ST
Standard length (mm)	19.3–22.7					
Total length	71.2–79.8	74.8	3.07			
Head length	34.8-37.2	35.9	0.00			
Predorsal length	50.2-57.1	53.4	2.09			
Postdorsal length	49.2-53.7	51.6	1.48			
Prepelvic length	49.7-54.8	52.0	1.53			
Preanal length	67.4-76.4	71.2	2.78			
Length of body cavity	33.9-40.9	37.5	2.52			
Length of anal	17.7-21.8	19.9	1.15			
Base of dorsal	17.6-20.4	18.7	1.06			
Length of dorsal	24.0-30.1	27.2	1.90	68.3-81.9	75.8	4.93
Length of pectoral	16.5-20.2	18.1	1.23	46.6-54.7	50.4	3.31
Length of pelvic	18.0-21.0	19.4	0.94	51.0-60.3	54.1	2.97
Body depth	28.0-33.1	30.6	1.75	78.9-93.2	85.3	4.59
Length of caudal peduncle (C.P.)	16.7-21.2	18.8	1.64	47.0-61.0	52.5	4.58
Height of caudal peduncle (C.P.)	11.6-14.6	13.3	0.82	32.9-39.3	37.2	1.74
Head width				50.4-56.1	52.8	1.70
Depth of head				66.0-74.4	71.8	2.40
Eye diameter				22.2-28.8	24.9	2.01
Snout length				27.1-32.4	30.0	1.60
Interorbital distance				28.1-35.9	32.4	2.32
Gape of mouth				26.0-39.2	29.4	4.13
Predorsal length/ Postdorsal length	96.2-107.3	103.5	3.12			
Length of C.P./ Height of C.P.	61.1-79.0	71.3	6.29			

Fig. 1. Lateral view of *Puntius mudumalaiensis* sp. nov.

at the edges.

P. mudumalaiensis sp. nov. differs from all the *Puntius* species known so far. However, it is related to *P. melanostigma* in body shape and the lateral band. But it can be easily differentiated by its lesser number of predorsal and lateral transverse rows of scales (7-8 and 5/3 in *P. melanostigma* whereas in *P. mudumalaiensis* it is 9-10 and 5 1/2 / 3 1/2 respectively. The dorsal spot is also absent in *P. melantostigma*

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A NEW SPECIES AND A NEW RECORD OF THE REMARKABLE GENUS *DELISLEA* GIRAULT (HYMENOPTERA: PTEROMALIDAE) FROM THE ORIENTAL REGION [1]

T. C. NARENDRAN, K. ANIL AND K. CHANDRASEKHARAN[2]

(With three text-figures)

A new species of *Delislea* Girault from *Apanteles taragamae* Wilkinson is described and illustrated. It is compared with the only other known species, viz. *D. pattersoni* Girault.

INTRODUCTION

The genus *Delislea* Girault (subfamily Pteromalinae) is represented only by the type species, *D. pattersoni* Girault 1936 from Australia. It is close to *Isoplatoides* Girault, but differs from it in having a propodeum with distinct nucha and a striate clypeus with two small teeth separated by a narrow emargination (Boucek 1988). This is the first time that this genus is reported from the Oriental region.

This hyperparasitoid emerged from the cocoon of the braconid wasp, *Apanteles taragamae* Wilkinson, parasitic on *Opisina arenosella* Walker at Kallada, near Kayamkulam, Kerala.

Abbreviations used: EL-Eye length, EW -Eye width, Fl-Funicle segment, MS-Malar space, MV-Marginal vein, OOL-Oculo-ocellar line, PMV-Postmarginal vein, POL-Postocellar line, SMV-Submarginal vein, STV-Stigmal vein.

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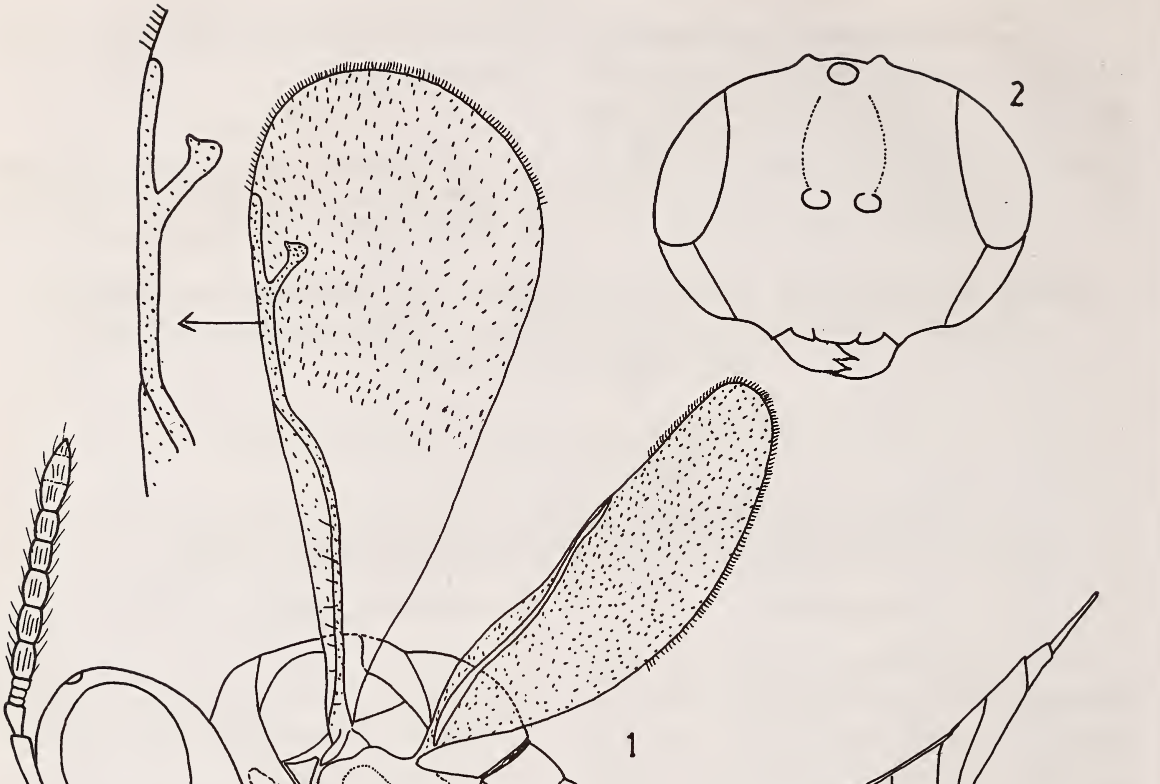
Delislea rahimani sp. nov. (Figs. 1-3).

FEMALE : Length: 2.72 mm. Body shining black; antennae and legs pale brownish yellow; mandibular teeth dark red; ocelli white, mid-coxa and gaster brown.

Head (Fig. 2) wider than long 27: 20; sculpture reticulate; clypeus longitudinally striate; mandibles large, left tooth 3 (right could not be seen since it is hidden by left tooth); clypeal margin with two small teeth separated by a narrow emargination; malar grooves distinct, MS: EL-8.5: 13; eyes oval, inner margin diverging, EL: EW-13: 9.5; frons 2x the width of eye; scrobes form a shallow depression, not reaching anterior ocellus, its margins blunt; antennae inserted above level of lower margin of eye orbit, slightly towards clypeal margin than to anterior ocellus; toruli separated from each other by about 0.68 of width of eye. Antenna (Fig. 1) short, filiform, antennal formula 11353; scape slender, elongated, almost reaching anterior ocellus; pedicel 0.83 of Fl1; funicle segments longer than wide, Fl1-Fl3 almost equal, F14-F15 equal, club 3-segmented, pointed at apex, slightly longer than F14 and F15 combined. Antennal meas-



Figs. 1-3. *Delislea rahimani* Narendran & Anil sp. nov., female
1. Entire, lateral view, 2. Head, frontal view, 3. Propodeum, dorsal view.

TABLE 1

DIFFERENCES BETWEEN *D. pattersoni* GIRAULT AND *D. rahimani* SP. NOV.

D. pattersoni Girault	*D. rahimani* sp. nov.
Legs, except fore and hind coxae and scape, are red	Legs, except hind coxae and scape, are pale brownish yellow.
F11 is longer than rest of the funicle segments	F11-F13 are equal.
Scape is 0.35 of rest of antenna	Scape is 0.45 of rest of antenna.
PMV is 0.95 of MV and STV is 0.56 of PMV	PMV is 0.77 of MV and STV is 0.64 of PMV.

urements: scape-1.00, pedicel-0.25, Fl1-0.30, F12-0.30, F13-0.30, F14-0.25, F15-0.25, club 0.55; ocelli large, OOL: POL-4.50 : 3.00; vertex smoothly rounded into occiput.

Thorax with reticulate sculpture, clothed with sparse, white hairs; pronotal collar ecarinate, its hind margin smooth, horizontal, its lateral corner sharp, protruding because of a furrow on the lateral panel of pronotum; notauli groove-like anteriorly, posteriorly faintly indicated, not reaching trans-sutal line; lateral corner of mesoscutal scapula narrow, with a depression and with raised margins; axilla widely separated with a small round pit at the base of antero-lateral corner below scapula, its outer margin carinate; frenum not indicated; propodeum (Fig. 3) similarly sculptured as rest of thorax, without a median carina, with a distinct nucha, plical furrow strongly curving towards median line but disappears before reaching middle, a shallow depression present behind spiracle; prepectus short, triangular, reaching base of tegula; macropterous, forewing (Fig. 1) hyaline, PMV 0.77 of MV, STV 0.64 of PMV. Relative measurements of veins-SMV: MV: PMV: STV-43: 18 :14: 9; hind tibia with a single spur.

Gaster dorsally collapsing, smooth and shining, slightly longer than thorax (38: 34); petiole short, subquadrate; 1st tergite largest, its anterior margin laterally produced forwards and reflexed outwards, hind margin convex; tergites 2-5 subequal, hind margins more or less entire; 6th and 7th tergites narrow apically; ovipositor sheaths slightly exserted.

MALE: Unknown.

Holotype: Female. INDIA: Kerala, Kallada (Kayamkulam), Coll. K. Chandrasekharan, 16 February 1990 from *Apanteles taragamae* Wilkinson.

This new species differs from the only other known species *D. pattersoni* Girault in colour and relative measurements of antennal segments and wing veins (Table 1).

The new species is named after Dr. U.C. Abdurahiman, for his contributions to the study of parasitoids affecting *Opisina arenosella* Walker. The holotype is kept in the collections of the Department of Zoology, University of Calicut. (Register No. N-8691).

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A NEW GENUS OF HARPACTORINAE (HETEROPTERA: REDUVIIDAE) FROM SOUTHERN INDIA[1]

DUNSTON P. AMBROSE AND N. SELVAMUTHU KUMARASWAMI[2]

(With two text-figures)

A new reduviid genus, namely *Neonagusta*, of the subfamily Harpactorinae, has been described and illustrated. A key to the Indian genera of the division Euagorasaria has been formulated.

INTRODUCTION

Out of the 16 genera described under the division Euagorasaria, by Distant (1902, 1910), only one genus, viz. *Nagusta* Stal has been reported to have bituberculated posterior lobe of pronotum.

A key has been formulated to the Indian genera of the division Euagorasaria of the subfamily Harpactorinae based on our observations and on the information available in the Fauna of British India volumes (Distant 1902, 1910).

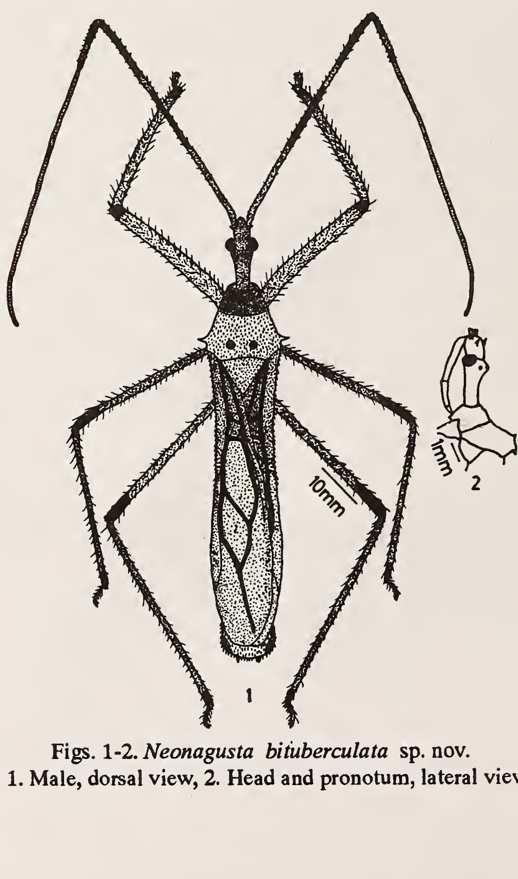
Neonagusta gen. nov.

Head longer than pronotum; antennal base spined behind; postocular area nearly twice as long as anteocular area; first rostral segment longer than the remaining two segments together; scape much longer than head and pronotum together; disc of posterior lobe of pronotum armed with two distinct tubercles; scutellum with its apex obtuse; legs long and slender; anterior femora incrassate.

Distant (1910), while describing the genus *Nagusta*, has suggested that the length of the head and the proportions of the anteocular and postocular portions differentiate *Nagusta* and that it could be placed after the division Euagorasaria and before the division Polididusaria. *Neonagusta* has close affinities to the genus *Nagusta* by its long head and discally bituberculate posterior lobe of pronotum. But it can be easily differentiated from the genus *Nagusta* by the long scape (longer than the head and pronotum together), the first rostral segment longer than the remaining two segments together and by the slightly incrassate anterior femora.

Neonagusta bituberculata sp. nov. (Figs. 1, 2)

Very pale stramineus, greyishly sericeus; postocular area of head except the ocellar area, basal part of second segment of rostrum, coxae and trochanters reddish; posterior lobe of pronotum, abdominal dorsum tinged with red.



Figs. 1-2. *Neonagusta bituberculata* sp. nov.
1. Male, dorsal view, 2. Head and pronotum, lateral view.

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KEY TO THE INDIAN GENERA OF THE DIVISION EUAGORASARIA

1. Anterior lobe of pronotum bituberculate posteriorly; anterior femora strongly incrassate, anterior tibiae incurved and spined before apex .... *Rihirbus* Stal
– Anterior lobe of pronotum not bituberculate posteriorly; anterior femora a little or not incrassate; anterior tibiae simple, not inwardly spined before apex 2
2. Anterior lobe of pronotum prominently tuberculate on each side .... *Isyndus* Stal
– Anterior lobe of pronotum not prominently tuberculate on each side 3
3. Pronotum discally unarmed 4
– Pronotum discally armed 10
4. Anterolateral margins of pronotal lobe with tubercles .... *Gallobelgicus* Distant
– Anterolateral margins of pronotal lobe without tubercles 5
5. First segment of rostrum considerably shorter than the second 6
– First segment of rostrum longer than the second 7
6. Antennal base tuberculated behind; posterior lobe of pronotum laterally armed with a long spine .... *Euagoras* Burmeister
– Antennal base spined behind; posterior lobe of pronotum laterally unarmed .... *Macracanthopsis* Reuter
7. Head about as long as pronotum ..... *Endochus* Stal
– Head shorter than pronotum 8
8. Anteocular and postocular areas about equal in length; lateral pronotal angles prominent but not spinous ... . *Cydnocoris* Stal
– Postocular area about half as long as anteocular area; lateral pronotal angles spinously produced 9
9. Spine on posterior angles of pronotum long and porrect .... *Serendiba* Distant
– Spine on posterior angles of pronotum short and not porrect .... *Villanovanus* Distant
10. Only posterior lobe of pronotum discally armed 11
– Both anterior and posterior lobes of pronotum discally armed 17
11. Posterior lobe of pronotum discally spined 12
– Posterior lobe of pronotum discally bituberculated 16
12. Head about as long as pronotum 13
– Head shorter than pronotum 14
13. Postocular area a little longer than anteocular area; hemelytra passing the abdominal apex .... *Platerus* Distant
– Postocular area much longer than anteocular area, hemelytra not quite reaching the abdominal apex .... *Lanca* Distant
14. Scutellum unarmed .... *Epidaus* Stal
– Scutellum armed with suberect spines 15
15. Scutellum with a single suberect spine; first rostral segment much longer than second ..... *Alcmena* Stal
– Scutellum with two spines, first and second rostral segments subequal .... *Occamus* Distant
16. First antennal segment shorter than the head and pronotum together .... *Nagusta* Stal
– First antennal segment longer than the head and pronotum together .... *Neonagusta* gen. nov.
17. Anteocular and postocular areas about equal in length; lateral abdominal margins dilated .... *Brassivola* Distant
– Postocular area longer than anteocular area; lateral abdominal margins not dilated .... *Bartacus* Distant

Head elongate (3.9 mm long), longer than pronotum (3.3 mm long), cylindrical; armed with a spine at the base of each antenna; postocular area (2.5 mm long) nearly twice as long as anteocular area (1.4 mm), both are demarcated by a sulcus between eyes; eyes laterally protruding; a pair of ocelli directed laterally placed on the elevated region of the postocular area immediately behind eyes; antennae long (23.7 mm) and slender, basal segment as long as posterior femora; scape and pedicel annulated, finely pilose; rostrum slightly curved, the first segment longer than the remaining two segments together, scarcely pilose.

Pronotum subtriangular; armed with two lateral spines (each spine 0.5 mm long); anterior lobe of pronotum and prosternum very much sculptured; posterior lobe of pronotum longer (1.9 mm) than anterior lobe of pronotum (1.5 mm), disc of posterior lobe of pronotum armed with two distinct tuberculous spines;

posterior lobe finely pubescent; anteriolateral angles of pronotum obtuse and posteriolateral angles of pronotum rounded; scutellum (2.3 mm long) unarmed, triangular, its apex obtuse, finely pilose; hemelytra (13.33 mm long) not reaching the abdominal apex; venation distinct on corium and membrane; the latter strongly rugulose; corium and clavus finely pilose; legs long and slender; fore femora (7.9 mm long) a little incrassate and slightly longer than fore tibiae (7.3 mm long), mid leg the shortest (14.5 mm) and hind leg the longest (22.0 mm), tarsus three segmented, first segment the shortest (0.2 mm) and third segment the longest (0.5 mm long); abdomen elongate; connexivum narrow; segmentation clear, abdomen beneath strongly carinate; apex of parameres visible from the abdominal apex; abdomen finely pilose.

Holotype: male, collected from Courtallam tropical rain forest (8°56′ N, 77°16′ 30″E) of Nellai Kattabomman District, Tamil Nadu on 2 May 1988. Coll. J. Antony Pushparaj. Allotype: not collected. Holotype is at present pinned and deposited (N.D. No. 11) at the reduviid collections of Entomology Research Unit, Department of Zoology, St. Xavier's College, Palayankottai, South India.

Etymology: The generic name *Neonagusta* is given because of its close affinities to the genus *Nagusta.* The species is named *bituberculata* because of its bituberculate posterior pronotal lobe.

Acknowledgements

We are grateful to the Rev. Fr. S.M. Felix, S.J., Principal and Rev. Fr. Stephen T. de Souza, S.J., Head, Department of Zoology, for facilities and encouragement, and to Department of Environment, Govt. of India, for financial support.

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A NEW *SAGINA* L. (CARYOPHYLLACEAE) FROM NORTH-WEST HIMALAYA[1]

R.D. Gaur[2]

(With a text-figure)

Sagina purii sp. nov.

Sagina saginoides (L.) Karsten affinis, sed differt habitu filiformi musciformi, foliorum vaginis glandularipilosis, noduliferis, floribus parvioribus tetrameris, solitariis, petalis quam sepalis majoribus, seminibus pyramidalibus, cum processibus verrucosis.

A small, erect, filiform, annual herb 5-8 cm high. Stem erect, branched, branches long, spreading. Leaves opposite, decussate, sessile, glabrous, linear to lanceolate (4-6 mm), both the leaves jointed at the base by a delicate decurrent sheath, which produces glandular knobbed hairs; leaf tip attenuate.

Flowers small, about 2 mm, white, solitary on axillary or terminal stalk, the cylindrical stalk enlarges in fruits up to 15 mm. Sepals 4, free, greenish white, about 1.5 mm, acute. Petals 4, broader than sepals, up to 1.8 mm, white and obtuse. Stamens 4, (rarely 2 or 3), filament long with dithecous anthers. Pollen grains spheroidal (28-32 μm), panporate, pores elliptical (8-10).

Gynoecium tricarpellary, syncarpous, superior and unilocular urn-shaped ovary with

[1]Accepted October 1991

[2]Plant Systematic Laboratory, Dept. of Botany, Garhwal University, Srinagar, Garhwal, Uttar Pradesh 246 174.

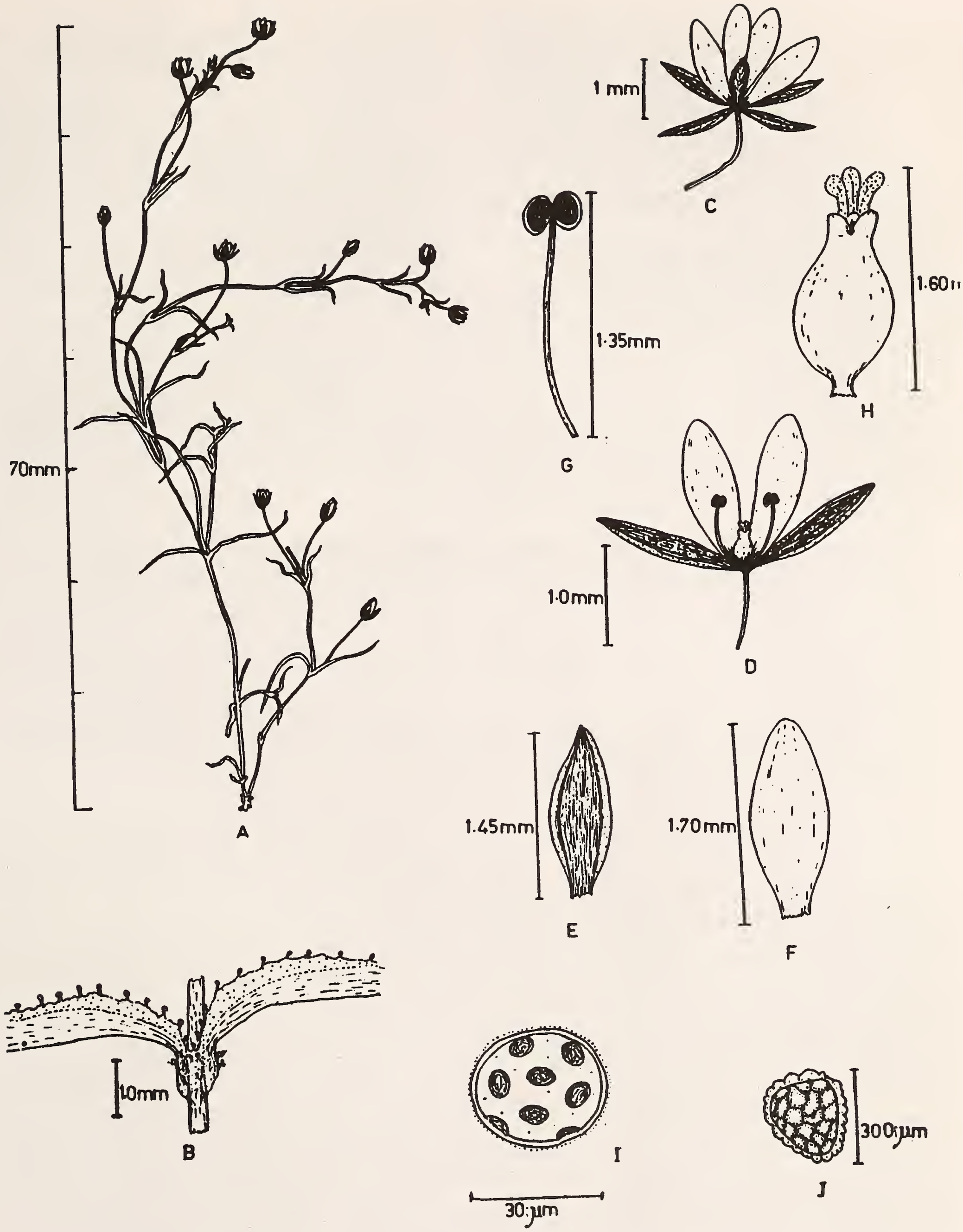

Fig. 1. *Sagina purii* sp. nov.
A. Habit, B. Leaf with leaf sheath and knobbed hairs, C. Flower, D. L.S. flower, E. Sepal, F. Petal, G. Stamen, H. Gynoecium, I. Pollen grain, J. Seed.

several ovules in free central placentation, terminating into 3 feebly distinct styles. Fruit capsule with persistent sepals bearing several seeds; seeds minute (275-325 µm), pyramidal, seed wall protrudes warty processes. Embryo curved (Fig. 1A-J). The specimens are deposited at Garhwal University Herbarium, Srinagar (GUH).

Flowers and Fruits: March-May.

Holotype: 12807A GUH, R.D. Gaur, 16 April 1991. Sanana, Almora, Uttar Pradesh, India, 1400 m a.s.l. **Isotype:** GUH 12807B, C, D, E, R.D. Gaur, 16 April 1991. Sanana, Almora, Uttar Pradesh, India.

Distribution and Ecology: Annual herb of open moist agricultural fields, associated with moss and small herbs. The specimens described were collected from Sanana, Almora district of Uttar Pradesh. The species is named after Professsor V. Puri.

Sagina purii sp. nov. is allied to *Sagina saginoides* (L.) Karsten, but can be easily distinguished by its filiform moss-like habit, leaf sheath with knobbed hairs, tetramerous flower, and petals which are larger than the sepals. (c.f. in other tetramerous species petals are either absent or smaller than sepals).

ACKNOWLEDGEMENTS

I thank Dr N.C. Majumdar, Ex-Deputy Director, Botanical Survey of India, Calcutta for his expert comments and Latin diagnosis of the taxon.

A NEW INOPEPLID SPECIES (COLEOPTERA: CUCUJOIDEA) FROM PATKOI HILL RANGE OF ARUNACHAL PRADESH [1]

T.K. PAL[2]

(*With two text-figures*)

A new Inopeplid species, *Inopeplus patkoicus* sp. nov. is described from the Patkoi hill range of Arunachal Pradesh, bringing the total number of Indian species of the genus to 10. A key to the Indian species of *Inopeplus* is included.

INTRODUCTION

Inopeplidae is a small, predominantly tropical family of cucujoid beetles. Subsequent to Crowson's (1955) recognition of the group as a distinct family, Sengupata, Pal and Mukhopadhyay (1977), Pal and Dutta (1982) and Pal (in press) described six species bringing the Indian species of the family to nine, recorded mostly from subtropical forest zones and tropical foot hills of Himalaya as well as from peninsular and insular parts of India. Pal (loc. cit.) recorded six species of this family from Arunachal Pradesh, collected from the Himalayan part of India's easternmost state.

Recently during field work in the Patkoi hill range of Arunachal Pradesh, the beetles of this family were noticed in woodlands near the Pangsau Pass, very close to the Burmese border. This reveals the possibility of occurrence of this primarily wood-inhabiting form in similar contiguous forest areas of the neighbouring country. This region is a component of the Assam-Burma Geological province which was a part of the Tethys sea in the Archean period. Repeated orogenic activity till early Pleistocene raised the upland to its present status (Singh 1989). The *Inopeplus* material, under study, is strikingly different from all known Indian species.

Inopeplus patkoicus sp. nov. (Figs. 1, 2)

General appearance (Fig. 1) elongated, flattened, shiny, blackish, elytra with pale

[1] Accepted October 1991

[2] Zoological Survey of India, Arunachal Pradesh Field Station, Itanagar 791 111.

KEY TO THE INDIAN SPECIES OF *Inopeplus* SMITH

1. Head and prothorax reddish 2
– Head and prothorax dark brown to deep black 3
2. Elytra blackish with a whitish rounded spot on each elytron, abdominal segments 4 and 5 exposed .... *biocellatus* (Motschulsky)
– Elytra entirely black and without any spot, abdominal segment 2 partly and segments 3 to 5 completely exposed .... *nitidus* Sengupta, Pal & Mukhopadhyay
3. Lateral margin of prothorax smooth 4
– Lateral margin of prothorax with two to three distinct denticles 8
4. Head across eyes distinctly wider than prothorax, pedicel and segment 3 of antenna distinctly shorter and narrower than other segments; lateral margin of pronotum broadly bordered............................... .... *distinctus* Sengupta, Pal & Mukhopadhyay
– Head across eyes slightly narrower or about as broad as prothorax, pedicel and segment 3 of antenna about as long as segments 4-10 but slightly narrower; lateral margin of pronotum finely bordered 5
5. Elytra entirely metallic black, last two abdominal segments exposed .... *nigricorpus* Sengupta, Pal & Mukhopadhyay.
– Blackish elytra partially whitish or pale-coloured 6
6. Anterior half of elytra paler and posterior half blackish; only last three abdominal segments completely exposed; puncturation on vertex minute, roundish with interspaces distinctly wider .... *andamanicus* Pal & Dutta
– Elytra blackish along its entire length with pale rounded spots: one or two pairs; more than last three abdominal segments exposed; puncturation on vertex coarse-elongate with interspaces narrower or about as wide as punctures 7
7. Two pairs of pale spots on elytra: one in both anterior and posterior halves; last three and half abdominal segments exposed, lateral margin of prothorax gradually narrowed and not markedly sinuate in posterior third; antennal segments slightly elongate and appear somewhat filiform .... *jairajpurii* Pal
– One pair of pale spots on posterior half of elytra; last four abdominal segments completely exposed; lateral margin of prothorax abruptly narrowed and distinctly sinuate in posterior third; antennal segments about as broad as long and distinctly moniliform .... *apatani* Pal
8. Lateral margin of prothorax with two posterior denticles .... *albonotatus* (Motschulsky)
– Lateral margin of prothorax with one anterior denticle in addition to two posterior denticles 9
9. A whitish longitudinal spot from base to near apex of each elytron; last three abdominal segments exposed; male genitalia with parameric lobes divergent apically ....*decisus* (Walker)
– An oblong sublateral longitudinal whitish spot on anterior half of each elytron; last four abdominal segments exposed with parameric lobes convergent apically .... *patkoicus* sp. nov

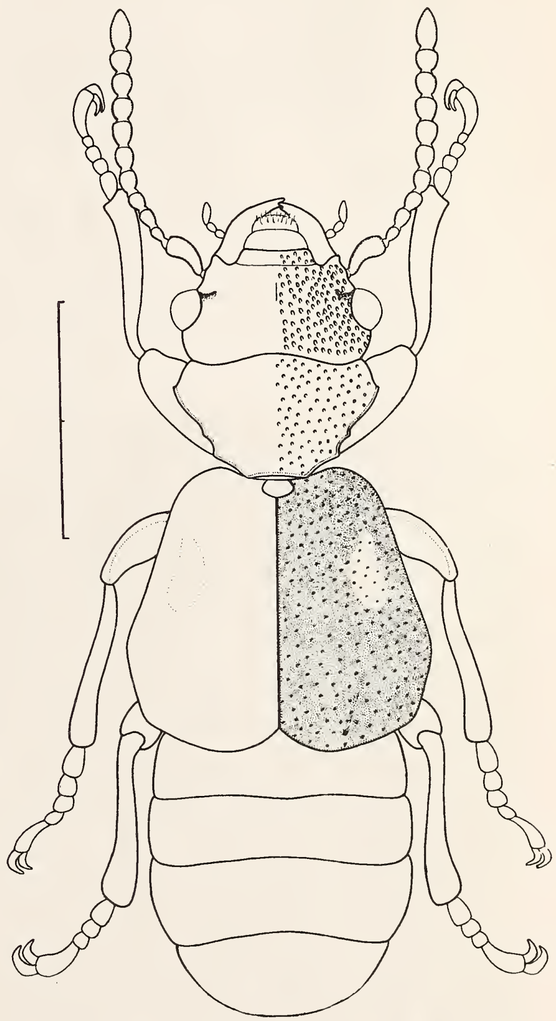

Fig. 1. *Inopeplus patkoicus* sp. nov., dorsal view (Scale 1 mm).

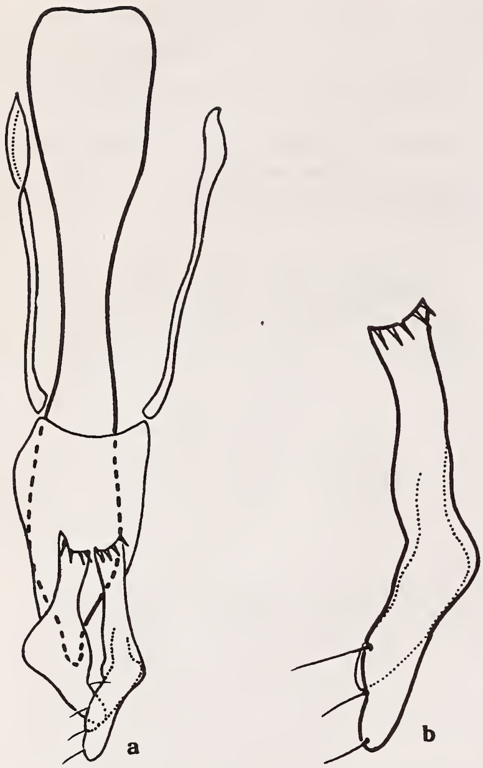

Fig. 2. Aedeagus of *Inopeplus patkoicus* sp. nov.
a. Dorsal view, b. Enlarged view of right paramere.

spots, last four abdominal segments exposed.

Head broader than long, apical margin truncate, fronto-clypeal suture distinct and nearly straight, apical margin of frons with transverse depression, a feeble medio-longitudinal impression on vertex; puncturation on vertex little elliptical, coarse and dense, interspaces about as wide as punctures near middle and closer posteriorly towards sides; eyes moderately large and finely facetted, a semicircular depression surrounding inner margin of eye less distinct, a short oblique depression arises near antennal base. Antenna moderately long and slender, scape moderately large and curved, pedicel shorter and narrower than scape, segment 3 slightly wider and longer than pedicel, segments 4-10 subequal and little elongate, segment 11 elongate and acuminate at apex; antenna unicolorous, blackish.

Prothorax triangularly transverse, flattened, widest across anterior teeth and narrowed posteriorly; lateral margin with one anterior and two posterior denticles, finely bordered from base to anterior teeth; puncturation on pronotum roundish, finer and sparser than on vertex, interspaces wider than punctures. Scutellum transverse, rounded at apex, impunctate.

Elytra about as broad as long, broadened posteriorly, puncturation fine and sparse; an elongate ovate sublateral pale spot on anterior half of each elytron, the margin of which less distinct; last four abdominal segments exposed.

Ventral surface shiny, fine punctures only on head and prothorax. Aedeagus (Fig. 2a, b) with gradually narrowed and broadly pointed apex of median lobe; parameres broad, foot-shaped and bilobed, a few setae at apex.

This species resembles *I. albonotatus* (Motschulsky) and *I. decisus* (Walker) but can be differentiated from the former species by the presence of an anterior denticle in addition to two posterior denticles on lateral margin of prothorax; apical lobes of paramere less pronounced with fewer setae. This species can be differentiated from *decisus* in having different pattern of elytral spots, more exposed abdominal segments, and in the structure of parameres being distinctly different.

Measurements of holotype: Total length 3.65 mm, width of head across eyes 0.85 mm, length of antenna 1.25 mm, length and width of prothorax 0.52 and 0.80 mm, length and width of elytra 1.24 and 1.26 mm.

Holotype male, INDIA: Arunachal Pradesh, Changlang district, Nampong, 300 m, 9 March 1990, T.K. Pal, *ex.* under bark; aedeagus dissected, mounted on cover slip and pinned with the holotype (Zoological Survey of India, Calcutta; A.P.F.S. Regd. No. AIV/1).

Etymology: The species is named after the hill range of north-eastern India from where it is reported.

ACKNOWLEDGEMENTS

I am indebted to the Director, Zoological Survey of India for providing necessary facilities to carry out this work.

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FIRST RECORD OF GENUS *APROCEROS* MALAISE (HYMENOPTERA, SYMPHYTA: ARGIDAE) FROM INDIA, WITH DESCRIPTION OF A NEW SPECIES[1]

MALKIAT S. SAINI AND AMARINDER S. THIND[2]

(With six text-figures)

A new species of *Aproceros,* i.e. *A. sikkimensis* sp. nov. has been described and illustrated. This represents the first record of this genus from India. So far only four species of this genus are known.

INTRODUCTION

Erected by Malaise (1931), the genus *Aproceros* is represented by only four species so far. Except the type species *Aproceros umbricola* from Siberia (Vladivostok), all the other species are known from Japan. The genus has the following characters: head broad and short, very strongly narrowed behind eyes (Fig. 4); flagellum in the female cylindrical, as long as the width of head; clypeus almost truncate (Fig. 5); inner margin of eyes almost parallel and distance between them nearly twice as long as the length of one eye; projection of the cheeks twice as long as the diameter of ocellus; forewing (Fig. 2) without intercostal crossvein and its radial field is open at the end, hindwing with two closed middle cells (Fig. 3). This is the first report of *Aproceros* from India. The description of *Aproceros sikkimensis* sp. nov. is also given.

Abbreviations used: A = Anal cell, AST = Anterior subbasal tooth, Ax = Axillus vein, B = Brachial cell, C = Costa, C1...4 = Cubital cells, CL = Clypeus, CN = Cenchri, D = Discoidal cell, EL = Eye length, FLG = Flagellum, IATS = Inner apical tibial spur, IDMO = Interocular distance at the level of median ocellus, LB = Labrum, LID = Lower interocular distance, M = Median cell, MB = Metabasitarsus, OATS = Outer apical tibial spur, OCL = Ocello-occipital line, OOL = Oculo-ocellar line, P = Posterior cell, PED = Pedicel, POL = Postocellar line, PST = Posterior subbasal tooth, R = Radial cell, S = Submedian cell, SB = Subcosta, SCP = Scape, St = Stigma.

Aproceros sikkimensis sp. nov. Figs. 1-6.

FEMALE: Colour: Body black, maxillary and labial palpi brown; all legs except outer sides of all coxae, basal halves of pro- and mesofemora yellow; wings subhyaline; costa,

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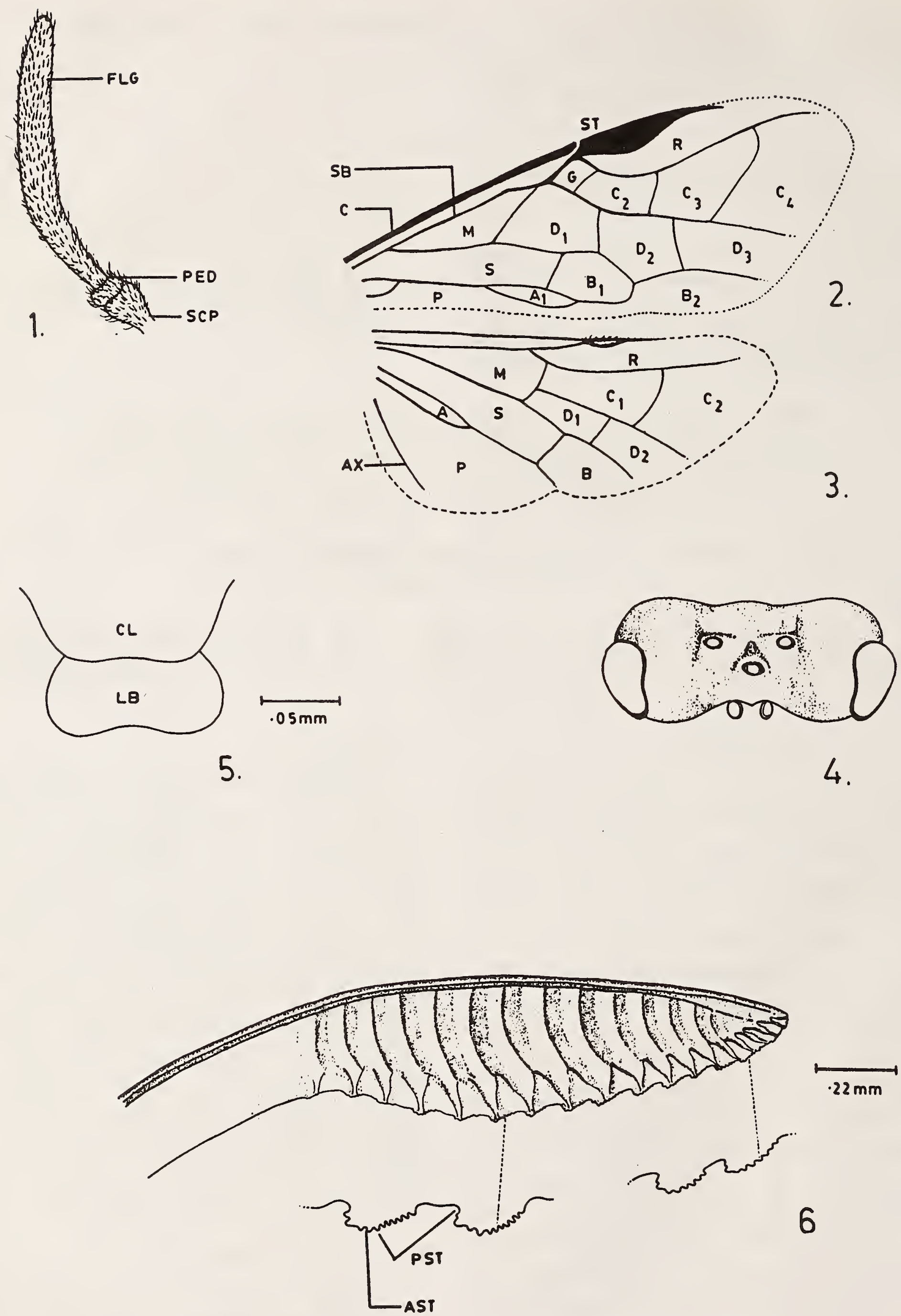

Figs. 1-6. *Aproceros sikkimensis* sp. nov. For abbreviations, see text.
1. Antenna, 2. Forewing, 3. Hindwing, 4. Antero-dorsal view of head, 5. Clypeus and labrum, 6. Lancet.

subcosta, stigma and venation brown.

Length 6 mm. Antenna (Fig. 1) equal to head width; scape as long as its apical thickness, pedicel shorter, much broader than long, flagellum round, sickle-shaped and its maximum thickness is equal to the apical thickness of scape; clypeus (Fig. 5) shallowly emarginated, broader than long in ratio 2:1; labrum shallowly emarginated with deflexed anterior margin, broader than long in ratio 2 : 1; malar space quite conspicuous, twice the diameter of median ocellus; supraclypeal furrow present; supraclypeal area moderately raised with a sharp median carina; lower margin of eyes at the level of antennal sockets; LID : IDMO : EL = 4 : 4.2 : 2; eyes slightly converging below; distance between lower margin of eyes is 2.2 x length of one eye; head without postgenal carina; frontal area roundly raised above the level of eyes; supra-antennal tubercle absent; median fovea absent and instead a blunt carina is present which is continuous with a supraclypeal carina; an area in front of median ocellus is distinctly roundly raised; supraorbital line at the level of lateral ocelli; circum-, inter- and postocellar furrows present; lateral furrows in the form of weak depressions; postocellar area subconvex with a median longitudinal depression, broader than long in the ratio of 5 : 2; 00L : POL : OCL = 1.4 : 1 : 0.8; head narrowing behind eyes; mesoscutellum sunken and well below the level of mesonotum, subconvex bounded by blunt lateral carina meeting at a tip; metascutellum flat above, sunken and well below the level of metanotum; cenchri fused along the middle line; mesepisternum obtusely raised without carina or acute apex; metabasitarsus longer than three following segments combined; tarsal claws simple.

IATS : MB: OATS = 1 : 3.3 : 1.3.

Lancet (Fig. 6) with 17 serrulae; head (Fig. 4) shown in antero-dorsal view.

Sculpture: Head not punctured, postero-lateral margins of mesonotum, lateral margins of mesonotal middle lobe and lateral edges of mesoscutellum with distinct large punctures; rest of the body almost not punctured, polished.

Pubescence: Body scatteredly covered with silvery pubescence.

MALE: Not found.

Holotype: Female, Sikkim: Chung thung-2000 m, 15 May 1987. (Regd. No. 1A/RIT). No paratypes.

Distribution: INDIA : Sikkim.

Diagnosis: The species is characterised by its black body and yellow legs except on outer sides of all coxae, basal half of pro- and mesofemora.

Etymology: The species is named after Indian state in which the collection locality falls.

ACKNOWLEDGEMENTS

We are grateful to Dr D.R. Smith, of USNM Washington for confirming the generic position of this species. Financial assistance provided by the CSIR New Delhi is also gratefully acknowledged.

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OBITUARY

PROF. R.M. NAIK

Prof. Ramesh M. Naik tragically passed away on 8 December 1991 in Rajkot. He was suffering from bronco-pneumonia for some time before he died. He is survived by his wife and son.

At the time of his untimely death, he had retired as the Head of the Department of Biosciences at Saurashtra University, and was actively working to set up a special department at the University, dealing with a variety of subjects related to Ocean Science and Culture.

Prof. Naik was born on 2 May 1931. He earned his doctorate for his work on avian muscle structure and physiology from the M.S. University of Baroda in 1959. He was awarded a Smith/Mundt Fulbright Fellowship at the Michigan State University from 1961-62. He was Lecturer and Reader in Zoology at the University at Baroda for several years before taking over as a Professor at the Department of Biosciences at Saurashtra University at Rajkot, where he worked for 13 years.

His first love was swifts, but he worked extensively on the house sparrow, blue rock pigeon, babblers and forest species. He supervised several masters and doctorate students covering a variety of disciplines of zoology, ornithology, icythyology and entomology. His interest in colonial waterbirds covered various aspects of the breeding strategies, feeding ecology, habitat utilization and conservation plans of resident species of herons and allies, waders, terns and migrant waterfowl. His work has been published in several national and international journals and magazines of repute.

He served with distinction on the editorial committees of *Colonial Waterbirds*, the *Journal of the BNHS, Proceedings of the Indian Academy of Sciences* and other journals, and was founding editor of *Pavo — the Journal of Indian Ornithology.*

He was a member of the faculty of science of many universities in India, and a Fellow of the American Ornithologists Union. He participated in and advised several regional and national committees on science, economic ornithology and conservation. He was a member of the scientific committees of the BNHS and Salim Ali Centre for Ornithology and Natural History.

Prof. Naik was not only a scientist but also a conservationist. He was a member and advisor of the WWF regional committee for Saurashtra and freely gave his time to both conservation activities and scientific enquiry. An able, confident man who could not stomach fools, he was outspoken and frank, well above the level of politics and petty jealousies that haunt the corridors of many institutions. His endearing sense of humour and politeness never deserted him even in bad health and he took everything in his stride, never getting flustered.

Where work was concerned, he was a hard taskmaster, expecting 100% from his students. He was a mentor to many; friend, advisor and father figure to his students. He commanded great respect from friends and colleagues, and could get an almost impossible task accomplished with a casual request. Such was his personality. His untimely death is a great loss to Indian ornithology.

TAEJ MUNDKUR
RISHAD NAOROJI

MISCELLANEOUS NOTES

1. DOES THE MANIPUR DEER *CERVUS ELDI* EXUDE A LEECH REPELLENT?

My father T.H. Tehsin shot a number of sambar *Cervus unicolor* and thamin *Cervus eldi* in north-east India in the 1930s. One aspect of his observations is particularly interesting. The habitat of the thamin is full of leeches. He found a large number of leeches on the carcasses of sambar he had shot, but none at all on carcasses of thamin he had shot in the same locality. He inferred that the thamin exudes a chemical repellent (possibly salt) which keeps leeches at bay.

There are plans by conservation authorities to build up the wild population of the endangered thamin by releasing captive animals. Due to long isolation from their natural habitat, the leech repellent mechanism in captive thamin may have atrophied. Before releasing captive animals, this aspect should be studied in more detail.

August 13, 1991 RAZA TEHSIN

2. BROOD OF THE INDIAN FIELD MOUSE *MUS BOODUGA* IN AN ABANDONED BAYA NEST

On 14 April 1990, some village boys brought two baya nests from the Rakhal (Reserved forest) adjoining our camp site on the edge of Fulay village in Chhari Dhandh, Kutch. One of the nests had an unusual opening on its anterior end close to the point from where the nest is usually suspended. The opening was smaller than the usual nest entrance, and seemed to have been neatly cut at a later date.

The opening led to the egg chamber which on examination revealed a field mouse *Mus booduga* with two young ones, whose eyes were still closed. We left the nest undisturbed and hung it up in a safe corner. On examining it again the next day, we found that one more young had been littered in the night.

The adult mouse had by now got used to the nest's new location and used to emerge to forage both in the tent and outside and would return to the brood, where it would remain most of the time. According to Prof. I. Prakash (pers. comm.), this is the first instance of *Mus booduga* breeding in an abandoned baya nest. We again came across a similar nest near one of our netting plots. The nest was suspended on an *Acacia nilotica* tree, about 2.5 m from the ground and had a similar opening leading into the egg chamber. A *Mus booduga* emerged from the nest, and when we examined it further, a brood of three young ones was noticed. The above two instances indicate a hitherto unrecorded nesting behaviour of the field mouse.

S. ASAD AKHTAR
November 22, 1990 J.K. TIWARI

3. ADDITIONS TO THE BIRDS OF ASSAM – BLACKNECKED GREBE *PODICEPS NIGRICOLLIS* BREHM

On 6 January 1991, I and a few other members of the Florican Society were counting birds in the Deeper *Beel* Wildlife Sanctuary near Guwahati as part of the Asian Waterfowl Census. At around 1100 hrs about 1000 ducks were seen settling in the eastern half of the *beel*. We immediately took our boat to the spot. Among the ducks, two birds caught my attention.

Using 20x binoculars I identified them as grebes, but they appeared much smaller than the great crested grebe *P. cristatus*, and also smaller than the tufted ducks *Aythya fuligula* which were nearby. Soon they came out of the mixed flock of ducks and started diving, sometimes together, sometimes one after the other. On further observation, I noted the following characteristics: head (up to the eyes or just below), foreneck and back blackish or deep brown. Head (from around eyes to chin), breast and flanks white. The colour of the parts underwater were not seen. It was a pair of blacknecked grebes *Podiceps nigricollis* Brehm, in winter plumage, a first record for both Assam

and the whole of eastern India. The birds were seen in open water and observed for about 10 minutes.

According to the HANDBOOK OF BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983), the blacknecked grebe is an uncommon winter visitor to the Indian subcontinent, with just a few sporadic records from Uttar Pradesh and Maharashtra. The sighting is therefore the new easternmost locality for this species in the subcontinent.

January 19, 1991 A. CHOUDHURY

4. RECOVERY OF A RUSSIAN-RINGED ROSY (WHITE) PELICAN *PELECANUS ONOCROTALUS* LINN. IN KUTCH, GUJARAT

On 10 November 1989, Alimamad Manjothi, Range Forester, saw a large dead bird in Medisar Rakhal (23°22′ N, 69°30′ E) near Niruna village of Bhuj taluka, Kutch, Gujarat. It had a ring on one leg bearing no. Moskwa KK 2398 which is at present with Forest Division, Bhuj. The bird was identified by M.K. Himmatsinhji as an immature white (rosy) pelican *Pelecanus onocrotalus* Linn.

On enquiry with the ICBP/IWRB Pelican Research Group we found that the bird was a rosy pelican ringed as a pullet on 29 July 1989 at the Ily delta in the lake Balkash area (45°22′ N, 74° 08′ E), former U.S.S.R. This would mean that the young bird had flown a distance of at least 2800 km within three months 12 days.

The rosy pelican is partly resident and was first recorded breeding in the Great Rann of Kutch in 1960 (Ali, S., *JBNHS 57:* 414). It is mainly a winter visitor to Pakistan (Sind, Baluchistan) and northern India from Punjab to Assam (Uttar Pradesh, Rajasthan, Kutch, Saurashtra, north Gujarat, Andhra (Visakhapatnam) and Madras?).

S.N. VARU
November 8, 1990 M.B. KHATRI

5. POND HERON *ARDEOLA GRAYII* (SYKES) FEEDING ON BEES

While watching birds on the morning of 30 December 1990, close to Lalbagh Tank (12°57′ N, 77°35′ E) in Bangalore, we were attracted to four Indian pond herons *Ardeola grayii* perched on top of a 7 m tall Indian willow tree *Salix tetrasperma* Roxb., growing close to the tank edge. The willow tree was in full bloom and many small bees *Trigona leviseps* and rock bees *Apis dorsata* (Apidae : Hymenoptera) were observed visiting the willow flowers. The pond herons, perched precariously on the small end-branches close to the flowers, snapped their beaks at and swallowed every small bee that came within striking distance. Surprisingly, the herons were not observed capturing the rock bees.

Pond herons are chiefly ground foragers and are known to feed on animal matter mainly aquatic in nature (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1987). The present observation of peculiar arboreal behaviour and diet of the bird is therefore of interest.

J.N. PRASAD
February 14, 1991 J. HEMANTH

6. PAINTED STORK *MYCTERIA LEUCOCEPHALA* (PENNANT) IN KERALA

On a visit to the Periyar Tiger Reserve in Kerala in October 1990, I observed a painted stork *Mycteria leucocephala* (Pennant) there on the 19th afternoon, feeding alongside a pair of whitenecked storks *Ciconia episcopus* at the edge of the Periyar reservoir. This was not far from the Edapalayam watch tower, by boat. I saw a solitary painted stork, presumably the same individual, on three other occasions during the next two days.

On the morning after the first sighting, it was opposite the boat landing at Thekkady, again with whitenecked storks. That afternoon it was standing on one of the dead trees in the reservoir, off the Edapalayam landing. On the morning of 21 October it was back at the Thekkady boat landing, with a group of whitenecked storks. This sighting is the second record of the painted stork for Kerala.

March 7, 1991 KUMARAN SATHASIVAM

7. LONGTAILED DUCK OR OLD SQUAW *CLANGULA HYEMALIS* (LINN.) IN DEHRA DUN, UTTAR PRADESH

On 19 January 1991 we were conducting a waterfowl census on the Asan reservoir some 40 km west of Dehra Dun city. The reservoir is fed by Yamuna hydel canal and Asan river and occupies an area of approximately 25 ha. with maximum depth of about 10 m. The reservoir is surrounded by high hills; on the north and west by the Himachal Himalaya with altitudes up to 2000 m, and in the south by the Uttar Pradesh Shiwaliks with altitudes up to 1000 m.

Amidst a mixed flock of mallards *Anas platyrhynchos* and gadwalls *Anas strepera* in the shallow end of the lake was a brown-black and white duck. It had a pointed tail of two elongated central tail feathers kept slightly inclined upwards. The bill was short, with a rose pink terminal half and a dark basal half. It had a dark patch below the ear coverts, a dark brown back and collar broadening into a band on the breast. It did not take us long to identify the duck as the longtailed duck or old squaw *Clangula hyemalis*.

The duck soon took off and after circling around twice, settled on the deeper end of the lake. Here it dived into the water many times, staying inside for 5 to 10 seconds each time. Later it joined a 500 strong mixed flock of redcrested, common and tufted pochards (*Netta rufina*, *Aythya ferina* and *Aythya fuligula* respectively) and two great crested grebes *Podiceps cristatus*. It tucked its bill into its wings and rested after that.

The next day, the duck was spotted again at the same location by B.C. Chowdhury, N.H. Kakodkar and others, from the Wildlife Institute of India.

The longtailed duck has been recorded only five times in the Indian subcontinent – Pakistan (Baluchistan 1933, 1938; Sind 1936), Kashmir (Hokarsar 1939) and north-east Assam (Sadiya Frontier tract, 1935) (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983). Hence the present sighting constitutes a record in the Indian subcontinent after a gap of more than 50 years. Moreover, the earlier records were made in the border areas of the subcontinent. Dehra Dun being well inside the Indian mainland, the present sighting has special significance.

DHANANJAI MOHAN
NITIN D. RAI
ARUN P. SINGH

March 11, 1991

8. EASTERN STEPPE EAGLE *AQUILA RAPAX NIPALENSIS* HODGSON KILLING MOBBING BRAHMINY KITE *HALIASTUR INDUS* (BODDAERT) AT PT. CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

Mobbing in birds mostly involves the noisy, massed attack on a predator by a number of smaller birds. Crows and jays often attack hawks or owls. According to Welty (1982) mobbing is an adaptive response to predation.

The eastern steppe eagle *Aquila rapax nipalensis* has been reported as a vagrant at Point Calimere Wildlife Sanctuary, Tamil Nadu (Natarajan *et al.* 1990). On 27 November 1988 two brahminy kites *Haliastur indus* were observed chasing (mobbing) a steppe eagle. The eagle ducked thrice but the attack by the brahminy kites became intense. At that juncture the steppe eagle flew up and away from the brahminy kites, then swooped down on one of them, which finally fell to the ground. Immediately, the steppe eagle glided down, picked up the kite and went under cover. However, it left the kite on the ground and flew off when it was disturbed by one of us. The kite was dead. The next day, the same eagle was mobbed by a brahminy kite, which this time was attacked in the air and fell to the ground. We caught the brahminy kite, and noticed that the right wing was broken.

The killing of mobbing carrion crows *Corvus corone* by the golden eagle *Aquila chrysaetos* has been reported earlier (Walker 1983). This observation of the killing of mobbing brahminy kites by the steppe eagle is a new record.

S. ALAGAR RAJAN
P. BALASUBRAMANIAN
V. NATARAJAN

December 4, 1990

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9. PIED HARRIER *CIRCUS MELANOLEUCOS* (PENNANT) IN SOUTH-EAST RAJASTHAN

The HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali and Ripley 1983) states that the pied harrier *Circus melanoleucos* is a winter visitor to the eastern parts of the Indian subcontinent from West Bengal, Bihar, Orissa, east through Bangladesh and Burma.

It is a rare visitor to Kerala, Tamil Nadu, Karnataka and eastern Madhya Pradesh and is considered to be a rare vagrant to Andhra Pradesh and Maharashtra. It is not recorded north of Bombay and west of Gorakhpur. It was sighted at Karera Bustard Sanctuary in north-west Madhya Pradesh (Rahmani 1988, *JBNHS 85 (2):* 419-420).

I saw a male pied harrier on 15 November 1990 at Lakhawa village near Kota in south-east Rajasthan (25°10′ N, 75°52′ E), sailing low over a wheat field. I watched it with 20x50 binoculars for about three minutes from close range (the field was just across the road). Its black culmen and head, contrasting black and white plumage made identification very easy. It was seen on two subsequent occasions, 9 December (near village Ranpur) and 30 December 1990 (near village Lakhawa). I presume it was the same bird as all the sightings were within a radius of 2-3 km.

February 8, 1991

RAKESH VYAS

10. BIOMETRICS OF THE COLLARED PRATINCOLE *GLAREOLA PRATINCOLA MALDIVARUM* J.R. FORSTER

During September/October 1990, as part of an ongoing study on bird migration by the BNHS, several individuals of the collared pratincole *Glareola pratincola maldivarum* were banded in Sullurpet marsh adjoining Pulicat Bird Sanctuary in south coastal Andhra Pradesh.

According to Ali and Ripley (1987) the collared pratincole is described as resident/locally migratory, spreading in winter over the Indian peninsula. Some authors (Prater *et al.* 1977, Vaurie 1965) treat this race as a distinct species, while Ripley (1982) describes this as a subspecies of the nominate race. Since there is little published information on this race occurring in India, an attempt has been made to briefly describe the biometrics of the species.

The grazing lands near Sullurpet attracted large flocks of the collared pratincole (total nos. 1000-1200) during the third week of September 1990. All the birds were seen arriving at their roosting grounds by dusk to settle down in the fields. A total of 61 individuals (58 adults, 3 juveniles) were banded and released 1-2 hours after capture. The measurements are summarised in Tables 1,2.

Measurements given here were made on birds mistnetted during late evening hours at Sullurpet marsh between 22 September and 1 October 1990. The birds roosted in open grazing lands bordering the jheel. The following data were recorded for each bird.

1. Wing, bill, tarsus, tail (central and outer) length.
2. Weight.
3. Age, condition of moult.

Wing length: Adults were appreciably larger than juveniles, average 183.25 mm as compared to 173.6 mm. There seem to be similar changes in adult and juvenile birds as given by Prater *et al.* (1977). 31.14% of the birds caught had their primaries moulting.

Bill/ tarsus length: There was no marked difference in bill/tarsus lengths (Table 1), but juveniles seemed to average slightly smaller in both cases. Ali and Ripley (1987) give the tarsus length range as 30-33 mm for this race, which is somewhat less than the present measurements (Table 1).

TABLE 1
WING, BILL AND TARSUS MEASUREMENTS FOR COLLARED PRATINCOLE

	Wing* (mm)			Bill (mm)			Tarsus (mm)		
	Range	Average	SD	Range	Average	SD	Range	Average	SD
Adults (58)	160-194	183.25	6.32	12-15	13.55	0.67	30-36	32.33	1.34
Juveniles (3)	171-176	173.6	2.51	12-13.5	12.83	0.75	31-33	31.83	1.03

*Adult wing measurements for 56 birds

TABLE 2
DEPTH OF TAIL FORK IN COLLARED PRATINCOLE

	Central tail feathers (mm)			Outer tail feathers (mm)			Difference (mm)		
	Range	Average	SD	Range	Average	SD	Range	Average	SD
Adults	51-59	54.58	2.07	60-86	77.01	6.48	8-28	18.34	5.89
Juveniles	51-55	52.60	2.07	66-67	66.6	0.57	12-15	14.0	1.73

*Adult wing measurements for 56 birds.

Tail: In the collared pratincole, the tail dimensions are mainly taken into account with respect to the depth of the tail fork. Ali and Ripley (1987) use this criterion to segregate the two races (*G. pratincola pratincola* and *G. pratincola maldivarum*). In the current study the difference between central and outer tail feathers ranged from 8-28 mm for adults and 12-15 mm for juveniles (Table 2). Adults averaged 4.34 mm more than juveniles for the tail fork depth. The length of the outer tail feathers also showed considerable variation, ranging from 60-86 mm (av. 77.01).

Weight: There was considerable variation in the weights of individuals banded on each day of capture (Table 3). Birds banded on the first day of capture were heavier than those on other days. Adult weights for pratincoles ranged from 68-116 g, with an average of 95.81 g. Dietary in take may be an important factor in the variation in weights seen. Juveniles averaged 14.48 g less than adults (Table 4).

The movements of the collared pratincole have been previously described as locally migratory and nomadic. At Sullurpet marsh these birds were seen arriving in considerable numbers at their roost sites during the fourth week of September 1990 but few birds were seen during October 1990, indicating that they may be migrating elsewhere.

Adult birds seemed to show marked differences in wing length and weights when compared to juveniles. However, it is not clear why adults have longer wings than juveniles. Bill and tarsus lengths varied little with respect to age. Maximum changes were noticed in the weights both in relation to age as well as day of capture. Clark (1979) states that several factors may influence body weights in birds and this may be the reason why weights show more variability than other measurements. The larger weights of adults may also be due to their greater efficiency in hawking insects.

The amount of food consumed by the adults on various days may be the single largest factor responsible for increase in body weights (Table

TABLE 3
VARIATION IN WEIGHTS OF COLLARED PRATINCOLES

Day	Average	Range	n
	weight	(g)	(g)
1	96.50	86-112	18
2	98.88	78-116	27
3	87.23	68-110	13
4	86.6	78-92	3

TABLE 4
WEIGHTS OF COLLARED PRATINCOLE

	Range (g)	Average (g)	SD
Adult	68-116	95.81	9.23
Juvenile	76-86	81.33	5.03

3). Overcast weather conditions on the later days of capture may have reduced the available food resources.

Hence food consumption on these days may have been less, resulting in lower weights. The crop contents on the first two days, when weather conditions were normal, were full.

March 7, 1991

PRAKASH RAO
K.K. MOHAPATRA

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11. THREE ADDITIONS TO THE BIRDS OF KERALA, WITH A REPEAT SIGHT RECORD

Since September 1985, we have been regularly watching birds on the Malabar coast, and have been rewarded with sightings of hitherto unrecorded or rarely seen birds. Four such additions have been published by us and R. Venugopal (*JBNHS 86:* 458-9). Here we report three more additions to Kerala, and a repeat sight record.

Calidris tenuirostris (Horsfield): The eastern knot, hitherto unrecorded from Kerala, was sighted in the Katalundy estuary (20 km south of Kozhikhode) on 10 October 1987. Gradually their numbers rose from a brace on the first day, to 12 by the end of the month, but declined to two by 27 December.

Farther south in Sri Lanka, the eastern knot was first sighted by Ben King at Mannar on 4 March 1981, and subsequently several were sighted in 1983 at the same place (King, *JBNHS 86:* 10).

Limosa limosa (Linn.): The blacktailed godwit is said to have become common and plentiful in recent years in the coastal regions and Dry Zone areas of Sri Lanka (Hoffmann, *JBNHS 86:* 10). The first record for Kerala is from the Katalundy estuary on 13 September 1987, when three individuals were met with. On 6 March 1988 we came across about 50 individuals resting among teals, with a second group feeding in the shallow water nearby. This was in the estuary of the Bharathapuzha (Malapuram district).

During a subsequent visit to the same area on 13 March 1988, over 50 birds were found feeding in two or three loose flocks.

Tadorna ferruginea (Pallas): A solitary brahminy duck, hitherto unrecorded from Kerala, was first seen in Bharathapuzha estuary on 6 March 1988. The bird was present there on 13 March. E. Ayyapappan (pers. comm.) recalls having seen the brahminy duck in this estuary some 3-4 years back.

In addition to the above three new records for Kerala, we also found the crab plover *Dromas ardeola* Paykull in the Katalundy estuary on 21 October 1987. It remained there till 27 March 1988. The bird was first recorded from Kerala by K.K. Neelakantan and others (*JBNHS 77:* 503).

February 4, 1991

P.K. UTHAMAN
L. NAMASIVAYAN

12. SOME WADER RECORDS FROM COASTAL ANDHRA PRADESH

Pulicat Bird Sanctuary in south coastal Andhra Pradesh (13°25′ to 13°55′ N, 80°03′ to 80°19′ E) is the second largest brackishwater body in India, with extensive coastal salt lagoons and mudflats. The sanctuary has an area of about 450 sq. km of which a major part (84%) lies in Andhra Pradesh and the rest in Tamil Nadu. The sanctuary is a major wetland for migratory shorebirds on the

eastern sea board of India and vast numbers congregate here on the mudflats during the winters.

While carrying out bird migration studies at Pulicat during 1990 several species of waders were banded to study their movement patterns. Two species were ringed which are interesting in terms of their distribution and occurrence, as they are new records for Andhra Pradesh.

Rednecked phalarope *Phalaropus lobatus* (Linn.): Seven birds were ringed (Ring nos. A-232535 to A-232541) at Atkanithippa in Pulicat Bird Sanctuary on 21 September 1990. According to the HANDBOOK OF BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1987) the rednecked phalarope is mainly a winter visitor to the coasts of India and is seen mainly on the western seaboard. On the eastern coast there are very scanty records of this species, usually seen off the coast. As the birds were seen in the mudflats of the Sanctuary they were probably on passage.

Eastern knot *Calidris tenuirostris* (Horsfield): One was ringed on 19 September 1990 (Ring no. B-57777) at Atkanithippa. There are isolated records of the eastern knot on the eastern coastline, but its occurrence at Pulicat is a new record for Andhra Pradesh.

K.K. MOHAPATRA
PRAKASH RAO

November 30, 1990

13. CONFIRMATION OF THE BREEDING OF THE COMMON TERN *STERNA HIRUNDO* LINN. IN SRI LANKA

Reference is made to my paper on the breeding of the common tern *Sterna hirundo* in Sri Lanka (Hoffmann 1990, *JBNHS 87 (1)*: 68-72). In that paper I reported in detail on a breeding colony of the common tern, which I discovered in 1980 on a small island of coral debris (called Irrachchal), off the east coast of Sri Lanka. It is the first and so far only case of breeding of this tern anywhere in the Oriental region. Although there were strong indications (presence of many adult birds in breeding plumage) that breeding also took place in subsequent years, actual proof was lacking. For a number of reasons, but chiefly because of the ongoing ethnic conflict in Sri Lanka, I was unable to visit the island at the right time for a number of years.

But at the end of May 1990 I did pay another visit to the island. I had seen common terns in breeding plumage in the area as early as end March and, therefore, confidently expected to find evidence of breeding.

In 1980 I discovered the first five nest scrapes with eggs of the common tern at the end of May. By the end of June there were 41 nests with intact eggs, seven with broken eggs, two with downy chicks and about 12 abandoned nests, indicating a colony strength of over 60 breeding pairs of common terns. Thus egg laying started at the end of May, reached its peak by about the middle of June, and was completed by early July.

Large crested terns *Sterna bergii velox* regularly use this island for breeding; sporadic egg laying may take place during June, but reaches its peak during the second half of July.

By mid-July (when the breeding of common terns is almost completed) roseate terns *Sterna dougallii* and little terns *Sterna albifrons* may also breed on the island. The breeding seasons for the various species may vary somewhat in different years, in response to weather, feeding and possibly other conditions. I visited the island on 23 May 1990, at mid-morning. There were about 20 large crested, 8 roseate and 10 common terns perching on the coral pieces, all in unmistakable breeding plumage. The common terns stood out by their bright red bills with black tips, glossy black caps, bright orange legs and feet, dark edge on end of upper wing (in flight), and sleek silvery-grey and white plumage. All birds took to the air when I approached the island and when I landed. The large crested and roseate soon disappeared and only the common remained, variously circling in the air (with loud, high pitched cries of *twink*) and settling down at the highest point of the coral debris. The birds took off and settled nervously even when I was only 5 m away from where they had perched. When I got closer, some would dive at me with a harsh and angry *kaaarrr*. This continued throughout the period I was on the island.

I found five eggs in typical nest scrapes, marked and lined with small pebbles, shells and some feathers (as in 1980). The nests were widely spaced and close to or between large pieces of coral (some standing upright, thus providing shelter and shade, and perhaps protection against crushing

by large numbers of other terns roosting on the island at night). I also found three broken eggs, the deep orange yolk smeared on the coral pieces. There also were some empty nest scrapes, presumably in preparation of laying. The five intact eggs, one in each nest, were of the usual kind, heavily blotched and streaked, and of the following dimensions: 41x28 mm (two eggs), 43x29 mm, 40x28 mm, 41x29 mm.

The rather unrepresentative number of eggs gives an average of 41.2 x 28.4 mm, similar to the 1980 average (41.2x28.5 mm) and again smaller in width than the averages given in the literature (31.5 mm).

There were no nests or eggs of large crested or other terns. When I moved away from the nests and crouched at the edge of the island, the common terns immediately settled in the nesting area, and five birds sat on the five nests with one egg each. The others perched nearby on coral debris. In the evenings large numbers of terns use the island for roosting, as observed through the telescope from the shore.

It was my intention to visit the island again in mid-June, when I expected to find up to a 100 nests of common terns. Unfortunately the ethnic conflict broke out once again, involving the area directly in warlike operations, and I was prevented from carrying out my plan. Nevertheless, I am now satisfied that the common tern is a resident breeding bird in Sri Lanka.

The time of the year, size of eggs, type of nest scrapes, and identity of the breeding birds are the same as in 1980, and there is no doubt in my mind that the common tern would have bred on this island in the interim and will continue to do so every year if not disturbed. There is more than ample evidence of the all-year round presence on the east coast of Sri Lanka of common terns, including many adults in breeding plumage.

Two questions remain: First, are there other breeding colonies of the common tern in Sri Lanka? Although I was sure that this would be the case, a preliminary recce along the eastern coast from Valaichchenai to Foul Point did not reveal any other breeding colonies at the end of May 1990. Several rocky islands (some with vegetation, sand and coral debris) were visited, but no evidence of the breeding of terns could be found.

Obviously these potential breeding places should have been inspected again by the end of June/beginning of July, but events prevented this. Irrachchal is the only island of its kind known to me along the coasts of Sri Lanka, and until there is evidence to the contrary, I must now assume that it is the only place on which common terns regularly breed in Sri Lanka.

It is thus a unique location, with a unique tern population, and should be given fullest protection under the law as a conservation area to which access by humans would be prohibited at least during the egg-laying period, say from beginning of May to the end of August each year.

The second question revolves around the subspecies of the breeding common terns. I continue to think that it is more likely to be *S.h. hirundo* rather than *S.h. tibetana*. There is some visual support for this assumption, because all the birds seen have a pale silvery-grey mantle. In HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1969), *S.h. tibetana* in breeding plumage is said to be "darker and slightly browner above, darker below" than *S.h. hirundo*. Obviously a specimen will have to be collected, but I could not bring myself to shooting one of these birds over the nest.

July 6, 1990 THILO HOFFMANN

14. INDIAN SKIMMER *RYNCHOPS ALBICOLLIS* SWAINSON AND BLACK STORK *CICONIA NIGRA* (LINN.) – NEW ADDITIONS TO THE AVIFAUNA OF KEOLADEO NATIONAL PARK, BHARATPUR

Altogether 317 species of birds were recorded from Keoladeo National Park, Bharatpur, from 1980 to 1986 (Vijayan 1987). Subsequently in 1988 two more species – the Indian skimmer *Rynchops albicollis* and black stork *Ciconia nigra* were added to the list.

On 4 February 1988 a small flock of six Indian skimmers was seen feeding in one of the aquatic blocks of Keoladeo National Park. The birds were seen only for two days. The Indian skimmer has been recorded as a rare vagrant in inland tanks (Ali and Ripley 1983). The black stork was sighted on 3 April 1988 in the Park and could be seen only for four days. This stork is a winter visitor

to Pakistan and sporadically all over north India (Ali and Ripley 1983).

Even though the black stork and Indian skimmer were recorded in Delhi area by Abdulali and Panday (1978), they have never been recorded in Keoladeo National Park.

I thank Dr V.S. Vijayan, Project Scientist, BNHS for his help in the preparation of this note.

July 24, 1990 C. SIVASUBRAMANIAN

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15. UNUSUAL NESTING BEHAVIOUR IN THE DOMESTIC PIGEON *COLUMBA LIVIA* GMELIN

The domestic pigeon *Columba livia* is a monogamous species normally laying two eggs per cluth (Ali and Ripley 1987). Both parents share the duties of incubation and rearing the young. The incubation period varies from 16-18 days and chicks are fledged 21-25 days after hatching. Usually one and occasionally both the chicks from a clutch are fledged. Here we report unusual nesting behaviour of this species involving two females (A and B) which laid in the same nest and shared incubation duties.

Female A laid two eggs in its nest and started incubating them, sharing the duties with its mate. After three days of incubation, male A disappeared. Female B along with its mate built a nest near A's nest and was in the pre-laying stage when male B died. Female A continued incubation alone while female B repeatedly tried to enter A's nest, only to be repelled each time by female A. After two days, female B was able to enter A's nest and lay an egg. One day later B laid another egg, which was about the size of a marble. We removed the abnormal egg, leaving three eggs in A's nest. Subsequently both females shared incubation duties for the next 11 days. On the twelfth day, male A returned and expelled female B from the nest. Afterwards both male and female A incubated and hatched the three eggs and successfully reared all the chicks.

Among Columbidae, clutches of more than two eggs due to laying by more than two females in a common nest has been reported in the rock pigeon *Columba guinea* (Skead 1971), eared dove *Zenaida auriculata* (Murton *et al.* 1974), mourning dove *Zenaida macroura* (Weeks 1980) and ring dove *Streptopelia decaocto* (Cramp 1985). In Columbidae, laying by two females in a common nest may be induced by nest destruction or presence of a predator near the nest during the laying period (Goodwin 1967). Blockstein (1986) observed three cases in which a female and two male mourning doves attended a nest.

However, this is probably the first report of sharing of incubation duties by female columbids. Skadsen (1987) reported sharing of incubation duties by female tree swallows *Iridoprocne bicolor*.

May 2, 1990 RAJIV SINGH KALSI
RAJDEEP KALSI

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16. AN UNUSUAL NEST-SITE OF SPOTTED DOVE *STREPTOPELIA CHINENSIS* (SCOPOLI)

While surveying the hillock at Thondebhavi, about 83 km north of Bangalore, on 1 September 1990, (see also Ali 1942, *JBNHS 43*: 325-326), we came across an unusual nest-site of spotted dove *Streptopelia chinensis*. The nest was placed on the ground amidst a clump of lemon grass *Cymbopogon schoenanthus* about 10 m from the foothill. The scrape-nest was lined with rootlets.

According to the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, (Ali, S. and Ripley, S.D. 1983) spotted doves are known to nest only in vegetation, well above the ground. The site of the nest is of interest as it does not conform with earlier observations.

The boulder-strewn hillock, Arasalubande, (13°30′ N, 77°30′ E, 892 m above msl), where the nest was found was totally denuded, and not even a single tree or a dense bush was seen within about 200 m radius.

S. SUBRAMANYA
S. KARTHIKEYAN
J.N. PRASAD
T.S. SRINIVASA
B. ARUN

February 8, 1991

17. OCCURRENCE OF WRYNECK *JYNX TORQUILLA* LINN.

The HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1987) describes the winter distribution range of the wryneck *Jynx torquilla* as Maharashtra and western central province.

However, the species was sighted in our garden at Durg, Madhya Pradesh, first on 28 October 1990, subsequently daily between 9 and 12 November and later on 13 and 15 December 1990 and 7 February 1991. Repeated sightings of the species during the winter months suggest that it spends its winter in the area, and was not in transit.

A specimen taken from Charmae Sambalpur, Orissa (about 250 km further east) by N. Majumdar of ZSI (*JBNHS 76*: 162) is the other instance of the occurrence of the species outside the earlier known range.

February 13, 1991 A.M.K. BHAROS

18. SOUTHERN GOLDENBACKED WOODPECKER *DINOPIUM BENGHALENSE* FEEDING ON THE NECTAR OF BANANA TREE *MUSA PARADISIACA*

On 2 August 1990 at 0820 hrs, I saw a goldenbacked woodpecker *Dinopium benghalense* perching and feeding on the spathe of a banana tree *Musa paradisiaca* in my garden at Vedharanyam, Thanjavur district, Tamil Nadu. The banana tree had a few bunches of unripe fruits and flowers.

The bird was perched on the tip of the spathe and was probing with its beak into the free perianth (inner perianth) of flowers and drinking the nectar. Changing its perch frequently, the bird made a full round of the spathe and attended to several flowers. After about 7 minutes the bird flew away. The next day also at about 0615 hrs I noticed a woodpecker feeding on nectar from the same tree.

Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) recorded insects, larvae, ants, centipede, spider, fruits, berries and flower nectar of *Erythrina, Salmalia, Acrocarpus* and *Grevillea* as the food items of this woodpecker. Now the nectar of banana tree should also be included in the list of food items.

August 20, 1990 P. BALASUBRAMANIAN

19. OCCURRENCE OF THE INDIAN GREAT BLACK WOODPECKER *DRYOCOPUS JAVENSIS* (HORSFIELD)

The sighting of a solitary Indian great black woodpecker *Dryocopus javensis* (Horsfield) by the late Salim Ali in the Bastar district (82°E) was reported in *JBNHS 49:* 787. This led to the speculation that though till then unrecorded, the bird may extend eastwards along the Satpura trend of mountains as it does southwards from the Surat Dangs in Gujarat along the Western Ghats to Kerala and Tamil Nadu. Since then only one other record has been reported by Ripley and Beehler from the Visakhapatnam Hills (Eastern Ghats) in selectively loggged forest at Jyothimamidi (*JBNHS 84:* 558).

During a visit to the Udanti Sanctuary (about 20°15′ N, 82°15′ E,) in the south-eastern part of Raipur district, I sighted about 30 of these woodpeckers in different localities on 10 and 11 May 1987. It had rained the previous two nights and hence humidity was quite high.

On a second visit to the Sanctuary from 25 to 28 May 1989, only two birds were encountered. It was very hot (*c.* 44°C) during the period, and light showers were recorded on 25 May. In the interlude between the two visits neither deforestation nor any significant disturbance to the bird's habitat was observed.

Enquiries revealed that the Indian great black woodpecker was noticed in quite good numbers in the area prior to my visit. Hence sightings are seemingly dictated by climatic conditions obtainable at the time, and are influenced by its local movements.

November 19, 1990 A.M.K. BHAROS

20. OCCURRENCE OF THE PHILIPPINE SHRIKE *LANIUS CRISTATUS LUCIONENSIS* LINN. IN COASTAL ANDHRA PRADESH

In the course of bird ringing at Sriharikota island (13°25′ to 13°55′ N, 80°03′ to 80°19′ E), Andhra Pradesh, as part of the ongoing research project of the BNHS, we caught a brown shrike *Lanius cristatus* on 14 April 1990 in one of our mistnets, located in the scrub jungle just behind the SHAR (Space Research Centre) Guest House. Although the bird superficially resembled the nominate race (a common winter visitor here), close examination revealed that it had a greyish white forehead and a greyish brown crown. One of us (VS) who had seen this bird in Port Blair, Andamans, identified it as the Philippine shrike *L. c. lucionensis* Linn. It had wing and tail measurements slightly higher than those of the nominate race. Unfortunately it was not possible to photograph the bird due to restrictions imposed for security reasons. The bird was ringed with BNHS ring AB-135377, measured and released.

Wing and tail measurements for the bird were 94 and 94 mm respectively, as compared to 80-89 mm (wing) and 78-89 mm (tail) for *L. c. cristatus.*

It was sighted subsequently in the same locality twice on 19 and 20 April 1990.

According to Ali and Ripley (1987) this subspecies is a winter visitor (September-April) chiefly to the Andamans and Nicobar. The only record from the Indian mainland has been from Kerala (Hume 1876). Its wintering habitat has been described as secondary jungle, gardens around habitations and forest clearings for settlements on hills and plains.

Ripley (1982) *vide* Stuart Baker (1902, 1920) suspects *L.c. lucionensis* to breed in North Cachar as it does in the subtropical parts of western Sichuan (Szechuan). There is every likelihood, therefore, that earlier record were confused for the nominate bird.

K.K. MOHAPATRA
November 28, 1990 V. SANTHARAM

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21. OCCURRENCE OF LONGTAILED MINIVET *PERICROCOTUS ETHOLOGUS* BANGS & PHILLIPS IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

25 December 1989 at Keoladeo National Park, Bharatpur, dawned with a particularly heavy mist. On an early morning walk one of us (DN) wandered off the trail into an area of salt-bush *Salvadora persica* and found a few lesser whitethroats *Sylvia curruca* and bluethroats *Erithacus svecicus*. Then a party of 25-30 minivets *Pericrocotus* spp. moved rapidly through the bushes and, luckily, stopped just above DN. Small *P. cinnamomeus* and scarlet *P. flammeus* were quickly identified with a couple of adult males of each species as well as several females or immature males.

One of the party was clearly not of these species, appearing smaller than the scarlet, although still much larger than the small minivets. On closer inspection its bill seemed particularly short; and perhaps the main reason why its body and bill seemed small was that its tail was long, much longer than that of the scarlet minivets.

The bird's forehead and underparts were bright yellow, with the top of its head and back a slaty grey. Wings were black, with a prominent bright yellow inverted U-shape formed apparently by some secondary feathers, the greater and primary coverts and two or more primary remiges. Its rump was bright yellow, as was the whole of the outer rectrices, contrasting markedly with the black tail.

DN managed to watch the flock, and this individual, at close range for 10-15 minutes, using 8 x 40 binoculars. In the misty conditions, it seemed that the flock stayed much closer together, and allowed a closer approach, than usual. Reference to Ali and Ripley (1983) threw doubt on the initial identification as an adult female longtailed minivet *Pericrocotus ethologus*, as Plate 71 shows this species to have a bill almost as long as *P. flammeus* and also the tail is not shown in full.

Ewans (1989) and Abdulali and Panday (1978) include the shortbilled minivet *Pericrocotus brevirostris* as an uncommon winter migrant but *P. ethologus* is not recorded. DN was almost prepared to believe that he had been mistaken and had perhaps seen the shortbilled minivet—whose female is also not depicted fully in the HANDBOOK, being obscured by the male—the other author (CS) told him that he had seen and photographed a probable male longtailed minivet at the same locality on 22 December 1988.

On consulting the HANDBOOK we were convinced that both birds, seen in two successive winters, were longtailed minivet *P. ethologus*. The HANDBOOK records them straggling south to Jodhpur and Mount Abu in Rajasthan, so their occurrence at Bharatpur is not surprising. It seems clear that a sustained programme of passerine ringing would probably reveal other examples of this species in Rajasthan.

D. NORMAN
C. SIVASUBRAMANIAN

November 1, 1990

The late K.S. Dharmakumarsinhji recorded *P. ethologus* from Bhavnagar in Gujarat on 23 December 1982 (*JBNHS 82:* 657). A.G. Gaston found it a regular winter visitor in small numbers to the Delhi Ridge, and opined that *P. brevirostris* of the Checklist of the birds of Delhi, Agra and Bharatpur (Abdulali and Panday 1978) referred actually to *P. ethologus* (*JBNHS 75:* 123) —Editors.

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22. ADDITIONAL NESTING SITES OF REDVENTED BULBUL *PYCNONOTUS CAFER* (LINN.)

On 12 June 1989 in the Keoladeo National Park, Bharatpur, we found a nest of the redvented bulbul *Pycnonotus cafer* placed in the trunk of a kadam tree (*Mitragyna parvifolia*). The height of the nesting hole was 3 m from the ground and the depth of the hole was 30 cm. The hole was lined with grass and the nest appeared as cup-shaped and had four eggs, three of which ultimately hatched.

A few days later, one of us (T.S.) observed another nest of the redvented bulbul with three chicks. It was placed inside the deserted nest of a pied myna *Sturnus contra* in a babul tree (*Acacia nilotica*) on one of the dykes in the wetland area.

The nest was located about 8 m above the ground. The cup-shaped nest was made up of grass material and placed in the middle of the pied myna nest. The chicks of the nest fledged successfully after a week.

Nests of redvented bulbul have been occasionally observed in unusual spots: e.g. Lamba (1976) recorded a nest in a hole in a mud bank; Mundkur (1984) found one on a disused tubelight and Nanjappa (1989) saw one on the floating water hyacinth *Eichhornia crassipes*. Redvented bulbuls generally build their nests in shrubs, hedges, stunted date palms, on slender branches of trees and at the end of a pollarded branch (Ali and Ripley 1983, Vijayan 1978).

We are grateful to Dr V.S. Vijayan, Project Scientist, BNHS for his encouragement.

C. SIVASUBRAMANIAN
July 24, 1990 T. SUNDARAMOORTHY

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23. INDIAN BLUE CHAT *ERITHACUS BRUNNEUS* (HODGSON) IN BANGALORE

On 15 April 1990, while watching birds in the moist-deciduous habitat overgrown with bamboo *Dendrocalamus* spp. at Muthyala Muduvu (Pearl Valley), in the Madeshwara Range Forest (952 m above msl; 12°41′ N, 77°39′ E), 38 km south-east of Bangalore, a male Indian blue chat *Erithacus brunneus* (Hodgson) was sighted. The bright chestnut underparts offsetting the dark blue upper parts, white vent, short tail and a distinct white supercilium were unmistakable.

The bird flew down from a *Memecylon umbellatum* (Family: Melastomaceae) bush at the end of a dry stream bed, paused briefly and began hopping around within a metre from the bush, picking up something from the ground. Then, alerted by our presence, it flew away.

The present sighting is of interest, as except for a female found dead in the balcony of a building in the Indian Institute of Science campus on 9 May 1989 (Shyamal 1989, *Newsletter for Birdwatchers 39 (9 & 10):* 8-9) the Indian blue chat has not been sighted in Bangalore so far. Since the species is known to winter in Western Ghats, Tamil Nadu, Kerala and Sri Lanka, the birds seen in Bangalore could have been on passage during their outward migration.

J.N. PRASAD
February 5, 1991 T.S. SRINIVASA

24. ABNORMAL CLUTCH IN INDIAN BROWNBACKED ROBIN *SAXICOLOIDES FULICATA CAMBAIENSIS* (LATHAM)

On 30 April 1990, a nest of the Indian brownbacked robin *Saxicoloides fulicata cambaiensis* was observed at Aligarh (27°29' N to 77° 29'E) in a residential hostel. The nest, located on an electric meter board, was in active incubation stage with an unusually large clutch of seven eggs. The eggs were incubated till 5 May 1990 before the nest was finally abandoned. Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) have reported the normal clutch to be three, sometimes two. This unusual clutch is either due to erratic laying or due to use of the same nest site for subsequent broods. Robins are reported to use the same nest site for subsequent broods during their breeding period, but it is not known whether the same nest is used for the next laying if the previous clutch is unsuccessful and eggs are not removed.

The robin possibly laid eggs of this next brood after unsuccessful incubation of the previous one, thus leading to the mixing of the eggs of two clutches. It is possible that the eggs of the previous clutch would have been again incubated, as a result of which the freshly laid eggs could not be maintained at optimum temperature for hatching; consequently, none of them hatched.

December 10, 1990 SALIM JAVED

25. PIED GROUND THRUSH *ZOOTHERA WARDII* (BLYTH) IN BANGALORE

On 14 October 1990, while observing birds at the Gandhi Krishi Vignana Kendra, Bangalore, on National Highway No. 7, I noticed some movement under a tree with drooping branches touching the ground, offering a lot of shade underneath. On taking a closer look through 7x35 binoculars a thrush-like bird was seen hopping on the ground. Seeing me the bird became alert, flew and settled on an open canopied tree nearby. The bird remained in the canopy for nearly 20 minutes affording a very good view, and was identified as the pied ground thrush *Zoothera wardii* (Blyth).

Interestingly, the bird was seen in a lightly wooded area, a Botanical Garden (920 m), though it is indicated that the species occurs in the hills, frequenting dense forests and ravines. It is a bird of passage in the peninsula to its wintering grounds in Sri Lanka.

December 7, 1990 S. KARTHIKEYAN

26. RECORD OF THE RIVERINE TURTLE *TRIONYX LEITHI* FROM THANJAVUR DISTRICT, TAMIL NADU

A short field survey made in various localities of Thanjavur district, Tamil Nadu, in the months of August, December 1990, and March 1991 yielded the following three species of freshwater turtles: Madras pond turtle *Melanochelys trijuga*, Indian flapshell turtle *Lissemys punctata* and riverine or softshell turtle *Trionyx leithi*. While the first two species are known from the district, the record of *Trionyx leithi* is interesting.

A single specimen of *T. leithi* trapped from the Coleroon river, was purchased from a local fisherman near Kollidam village (Sirkali). This specimen, preserved at the museum of Madras Snake Park Trust, has the following morphometric details. CL = 12.5 cm, CW = 11 cm, PL = 10.5 cm, weight = 205 g.

There has been some confusion on the distribution of *T. leithi*. Smith's (1931) assessment of its range as Ganges and rivers of peninsular India has been proved to be wrong; caused by misidentification by Annandale (1915). In a recent reassessment of its distribution, Moll and Vijaya (1986) have recorded this species from Godavari river (Kotipalle, Andhra Pradesh), Balimela reservoir (Chitrakonda, Orissa) and Moyar and Bhavani rivers (Nilgiri and Periyar districts respectively) of the Cauvery drainage; the last one constituting the first record from Tamil Nadu and Cauvery.

Although *M. trijuga* and *L. punctata* are common and have a wide distribution in Tamil Nadu, *T. leithi* is much rarer, known only from Nilgiris and Periyar districts. The present record from Coleroon, Thanjavur district, is thus of significance. Coleroon is a tributary of Cauvery join-

ing the Bay of Bengal at Portonovo. Enquiries with the local fishermen revealed that large turtles with carapace length of more than 45 cm were common at Coleroon 15 to 20 years back.

We are grateful to the Trustees of the Madras Snake Park Trust and to A.N. Jagannatha Rao, Hon. Secretary and Founder–Trustee for their kind help, and encouragement; and to Dr R. S. Pillai, Research Officer and Trustee of M.S.P.T. for his suggestions for the improvement of this manuscript.

V. KALAIARASAN
R. KANAKASABAI
November 9, 1991 B. RATHINASABAPATHY

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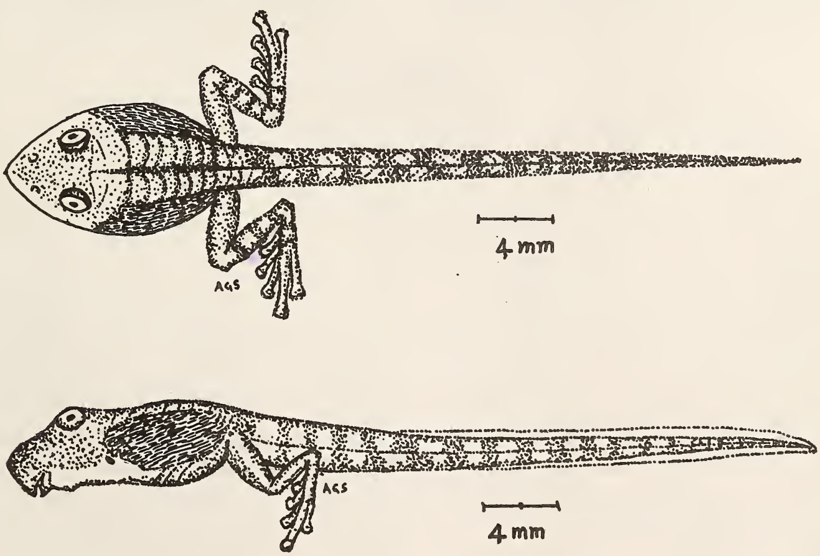
27. MORPHOMETRY, HABITAT, BEHAVIOUR AND FOOD OF THE TADPOLES OF LEITH'S FROG *RANA LEITHII*

(With three text-figures)

Leith's frog *Rana leithii* is distributed along the Western Ghats from Surat Dangs, south Gujarat in the north through Suriamal (Thane district), Khandala (Poona district), and the Karla caves to Panchgani in Satara district, Maharashtra, southward to Gersoppa in North Kanara, Karnataka (Abdulali and Daniel 1954, Chari and Daniel 1952, Daniel and Shull 1963). This frog is not uncommon in short grass and in ditches on hillsides and appears to be diurnal, at least during the rains (McCann 1932). The species is abundant in Matheran (a hill station 100 km away from Bombay) the type locality. The tadpole was described by Chari and Daniel (1952), but morphometric information is meagre. To study the morphometry of the tadpoles of this species in detail and to observe the habitat of adults and tadpoles, a collection trip was made to Matheran at the end of August 1991. Tadpoles were collected from the rock cuttings on the way to Matheran during the day and adults were collected at night.



Figs. 1-2. Tadpole of *Rana leithii*. 1. Dorsal view, 2. Lateral view.

Morphometry: The body of the tadpoles is oval, wider than high and flattened dorso-ventrally (Figs. 1, 2). The average body length in 20 tadpoles was 11.16 ± 0.68 mm (Table 1) and the average tail length was 29.40 ± 1.75 mm. The tail is more than two and a half times as long as the body. Tail muscle was almost squarish near the vent and tapers to a fine point. The tail fins are vestigeal. Dorsally the fin is seen as a ridge to half of the tail and broadens out slightly towards the end; whereas ventrally the tail has a groove in the middle which runs from the base of the tail till halfway to the tip, then forms a ridge which broadens out. From the main groove several minute grooves branch out.

Head slopes downwards, with bluntly pointed snout; nostril dorso-lateral, nearer to the eye than to the tip of snout. Eyes dorsal; interocular width greater than the internasal space. Spiraculum sinistral, inconspicuous, directed upward and backward, situated almost equidistant from snout and vent. Vent tubular and situated ventrally in median line, at the junction of tail with the hindlimb. In preserved specimens, a pair of small prominent grooves starting from behind the eye and meeting centrally with the median dorsal groove, run up to the base of the dorsal fin. The sides of the median groove have a ribbed appearance. Skin laterally rugose.

Mouth ventral with papillae on the sides of the upper and lower lip and on the edge of the lower lip. The edge of the upper lip is without papillae. Teeth rows have the formula 0: 4 + 4/2 + 2 : 2 (Fig. 3). The first row, though apparently undivided, is divided at the centre. The beak is oval in shape, the mandibles horny and black, with strongly serrated edges.

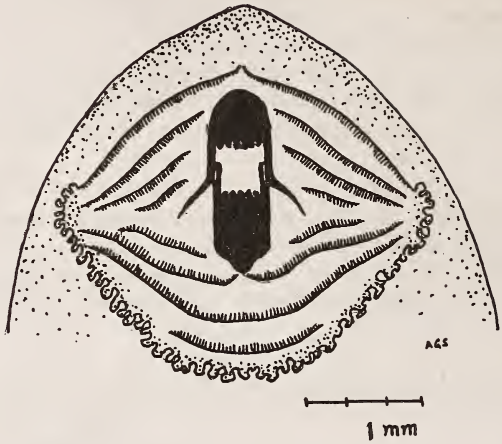


Fig. 3. Mouth of *Rana leithii* tadpole.

The body colour varies from uniform slaty to pale brown. Tail muscle and hindlimbs are pale brown and barred. The ventral side is dirty white.

Habitat: The tadpoles were collected from rock cuttings with gentle flow of water, having

TABLE 1

MEASUREMENTS OF 20 TADPOLES OF *Rana leithii* AT HINDLIMB STAGE

Measurements (mm)	Range (mm)	Mean (mm)	S.D. ±	Ratio of measurements to body length (%)
Body length	10.15-13.00	11.16	0.68	–
Body height	3.40-4.65	3.88	0.37	34.76
Body width	5.20-7.20	6.14	0.43	55.01
Head height	3.00-4.50	3.40	0.32	30.46
Head width	5.00-6.50	5.70	0.42	51.07
Internasal space	1.90-2.50	2.21	0.17	19.80
Diameter of eye	1.50-2.10	1.72	0.16	15.41
Interocular width	3.40-4.60	4.14	0.23	37.09
Mouth width	2.70-3.20	2.96	0.13	26.52
Snout to spiraculum	5.70-7.10	6.25	0.32	56.00
Tail length	27.00-33.30	29.40	1.75	263.44
Tail height	1.90-2.40	2.04	0.12	18.27
Diameter of tail muscle	1.50-2.20	1.81	0.15	16.21
Length of hindlimb	11.60-18.35	13.55	1.66	121.41

algal growth. As Chari and Daniel (1952) stated, the colouration of the tadpoles matches well with the colour of the slaty rock — with the rocks covered with brown algae, it is very difficult to distinguish them. Adults were collected from the ground (amidst short grasses, in leaf litter and ditches, between and near railway tracks, on mud-paths) as well as from tree trunks up to one metre above the ground. Adults were not observed around the tadpoles' habitat and were collected far from the tadpoles' habitat. Abdulali (1954) had observed large numbers of adults on the wet rock cuttings by the railway tracks and on wet rocks in flowing streams (tadpoles were absent from the stream itself). Though McCann (1932) and Abdulali and Daniel (1954) reported that this species was diurnal, I collected several specimens in the monsoon at night.

Behaviour: The tadpoles lack a tail fin, and are therefore less adept swimmers. They are adapted to life on wet rocks rather than in ponds or streams. The strong, black, serrated beak helps in nibbling the algal growth on wet rocks. Tadpoles were very active and agile, jumping onto the slippery surfaces when they were disturbed. They do not show any holding organs to cling on to wet, slippery rocks. Tadpoles in forelimb stage seem more active. I approached a group of tadpoles (most of which had forelimbs), and my slight movement made all the tadpoles jump to the bottom of the rocks from a height of 2 m. Some fell into the water running along the rocks. In the water they submerged to the bottom quietly and after for a few minutes came out of the water and climbed slowly on to their earlier location on the rock.

Food: The stomach contents revealed that the tadpoles had eaten large quantities of various species of diatoms (*Pinnularia, Navicula, Synedra, Cymbella* etc.) and a few species of filamentous algae.

I thank Vithoba Hegde, Field Assistant, who accompanied me on this field trip, and the BNHS for financial assitance.

January 18, 1992

A.G. SEKAR

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28. CANNIBALISM IN BUTTERFLY LARVAE

Cannibalism in butterfly larvae is reported by Moore (1912) and Deithier (1937). In Danianae it was first described by Field (1893), who recorded larvae of monarch butterfly attacking each other in captivity. Later Urquhart (1960) confirmed this observation and reported that larvae, besides attacking each other, also ate eggs. He further confirmed the observations of Balduf (1939) and Sweetman (1958) that cannibalistic behaviour in *Danaus* is abnormal and occurs under artificially crowded conditions in the laboratory. Brower (1960) conducted experiments on egg cannibalism in the monarch and queen butterflies *Danaus plexippus* and *D. gilippus*. This note deals with our observations *in vivo* and *in vitro* conditions.In July 1991 we were rearing common tiger *Danaus (Saltura) genutia* on the food plant *Ceropegia aculeata* collected from BNHS land at Goregaon, Bombay. While collecting fresh leaves of the food plant for the captive larvae, we observed that a leaf was eaten on the edge. On turning it over we found a second instar larva busy eating an egg. This induced us to investigate further.

We collected a few leaves, each having a single egg on its underside, for further observations. When these leaves were placed in glass bottles already having a second instar larva in each, we found that after wandering for a while, the host larva started denting the egg and shortly thereafter continued nibbling at it, consuming its contents in less than five seconds.

Later we saw that a third instar larva on coming in contact with the egg first dented the egg and after moving about on the leaf around the egg,

returned to it and consumed its contents. During these experiments, we also observed that when a second instar larva of *Danaus genutia* came in contact with a fourth instar larva, the latter regurgitated a greenish fluid which dried in a few minutes. This is perhaps an item of chemical defence mistakenly trigerred by tactile stimulus (see Rauch 1977).

A second instar larva of the blue tiger *Tirumala (Danaus) limniace* on *Marsdenia tenacissima* was collected along with three leaves, each having an egg. The larva, when it came in contact with the eggs, crawled on them and did not show any interest in eating them. However, in the evening NC found two newly hatched larvae and one egg missing.

One of us (MH) observed that while rearing larvae of *Acarea violae* on a garden variety of *Passiflora,* a newly formed pupa kept with three full-grown larvae in the morning was missing in the evening, presumably having been eaten by one of the mature larvae. An identical observation was made by Isaac Kehimkar (pers. comm.) while rearing the common rose *Pachliopta aristolochiae.* In his case a full-grown larvae kept with a pupa partially ate the latter before fresh leaves of *Aristolochia* could be furnished.

NARESH CHATURVEDI
MEENA HARIBAL

December 3, 1991

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29. FOOD PLANTS OF BLISTER BEETLE *MYLABRIS PUSTULATA* THUNB. (COLEOPTERA : CANTHARIDAE) FROM PT. CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

TABLE 1
FOOD PLANTS OF BLISTER BEETLE AT PT. CALIMERE SANCTUARY

Species	Family	Parts eaten
Tribulus terrestris L.	Zygophyllaceae	Flower
Salacia chinensis L.	Hippocrateaceae	Tender shoots
Canavalia ensiformis DC.	Papilionaceae	Flower
Pongamia pinnata (L.) Pierre	Papilionaceae	Flower
Dichrostachys cinerea (L.) W. & A.	Mimosaceae	Flower
Prosopis chilensis (Molina) S.	Mimosaceae	Flower
Opuntia dillenni (Ker-Gawl.) Haw.	Cactaceae	Flower, fruit
Catunaregam spinosa (Thunb.) Tiruvengadum	Rubiaceae	Flower
Salvadora persica L.	Salvadoraceae	Flower, fruit
Ipomoea obscura (L.) Ker-Gawl.	Convolvulaceae	Flower
Rivea hypocrateriformis Desr. Choisy	Covolvulaceae	Flower
Clerodendrum inerme (L.) Gaertner	Verbenaceae	Flower
Gmelina asiatica L.	Verbenaceae	Flower
Excoecaria agallocha L.	Euphorbiaceae	Tender shoots

The blister beetle *Mylabris pustulata* Thunb. is very common in south India and is a pest on numerous crops and other plant species. This beetle feeds on the flowers and tender shoots of many plants such as cotton, gogu, red gram, groundnut, cowpea, lab-lab, cucurbitaceae, prickly pear, garden species of *Hibiscus*, rose plants and the fruits of *Artocarpus* species. (SOME SOUTH INDIAN INSECTS AND OTHER ANIMALS OF IMPORTANCE, Fletcher, T.B. 1914, MANUAL OF FOREST ZOOLOGY FOR INDIA, Stebbing, E.P. 1977).

While studying plant-animal interactions at the Pt. Calimere Wildlife Sanctuary, Tamil Nadu, I observed this beetle feeding on flowers and fruits of the plants listed in Table 1. However, they were more frequently noted on the flowers of *Canavalia ensiformis* and *Opuntia dillenni*, which indicates that the beetle is a serious pest on these two species of plants.

My sincere thanks are due to Prof. P.V. Bole, President, BNHS, for encouragement.

December 3, 1991 P. BALASUBRAMANIAN

30. NEW DISTRIBUTIONAL RECORD FOR *INDIALONA GANAPATI* PETKOVSKI (CRUSTACEA : CLADOCERA) FROM UJANI WETLAND, MAHARASHTRA, WITH FIRST DESCRIPTION OF MALE AND REPRODUCTIVE FEMALE

(With ten text-figures)

Indialona ganapati was originally described by Petkovski (1966) on the basis of parthenogenetic females from Ahmedabad, but he did not give sufficient characters for its diagnosis. Smirnov (1971) redefined the genus *Indialona* on the basis of literature and added a few more species from other genera like *Alona globulosa* Daday, *A. macronyx* Daday and *Euryalona annandalei* Daday in this genus by using characters such as the high body and a single head pore.

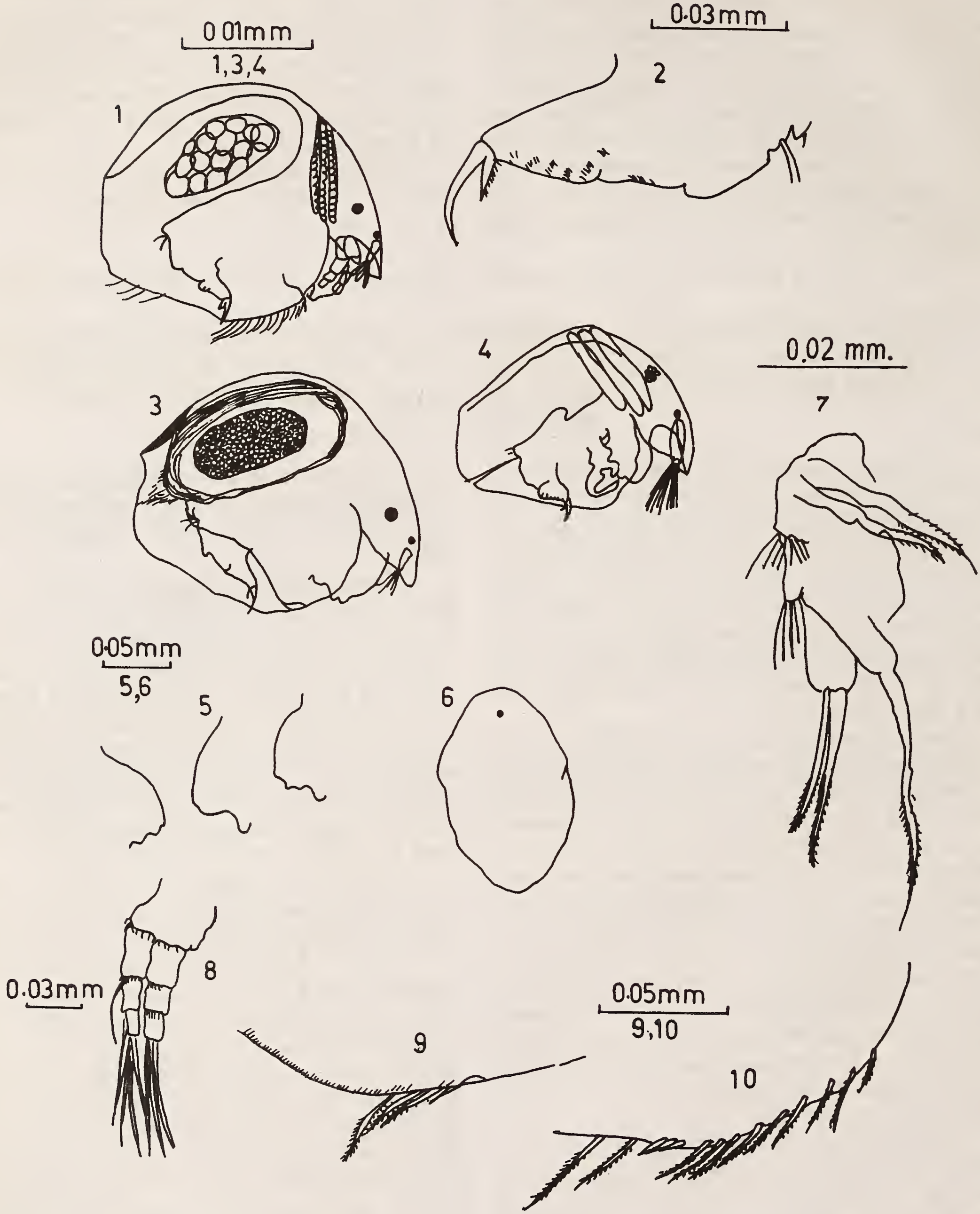
Later, Rajapaksa and Fernando (1987) revised the genus using fresh material collected from all over the world. They have completely changed the status of the genus by retai..ing only *I. ganapati* in this genus. *I. globulosa* was transferred to a new genus *Notoalona*; *I. macronyx* was reassigned to genus *Alona*, while *E. annandalei* was kept due to non- availability of material for study. *E. annandalei* was originally described from eastern Tibet. Though Rajapaksa and Fernando (1987) and later on Michael and Sharma (1988) have made some observations on *I. ganapati* from material collected from Bhopal lake, Madhya Pradesh, they have only used parthenogenetic females for their studies and redescription.

While studying the Cladocera collected from Ujani wetland, Pune district of Maharashtra, I came across a few males, reproductive females and several parthenogenetic females, which are described in this note with detailed diagnostic characters. The description of this species has great significance because this genus of Cladocera is found only in India, with the above mentioned sole species. This is only the third record of the species in India, the first being from Ahmedabad (Gujarat, type locality) and the second from Bhopal (Madhya Pradesh).

Parthenogenetic female: Length 0.27-0.29 mm. Body nearly circular. Head shield with rounded anterior and posterior margin, with one head pore. Mandibles short and thick, situated between the head shield valves. Posterior margin of valve about half the maximum height. Posterodorsal angle distinct, slightly protruded. Posteroventral corner rounded, without spinules. Valve with sparse setae on the ventral margin. Rostrum blunt. A single head pore situated slightly farther from eye than is the eye from ocellus.

Antennules almost reaching apex of the rostrum. Aesthetases almost uniform in length, slightly longer than the length of rostrum. Setae on antenna : 0-0-3/1-1-3; segments as long as labrum. Seta on proximal segment small, reaching apex of third segment. Preanal and postanal parts of postabdomen are of almost equal size. Ocellus smaller than eye, situated halfway between eye and apex of rostrum. Labral plate rounded, with a notch at the apex. Ventral bulge of valve with a few grouped setae, and setae posterior to it arise from small protuberances. Two very large ejector hooks on first leg. Legs IV and V smaller than the preceding legs. Shape and armature of the postabdomen is typical of this genus. Length-height ratio of body 10 : 7.5.

Reproductive female: Sometimes called Ephippial female. Length 0.27-0.29 mm. Body oval



Figs. 1-10. *Indialona ganapati* Petkovski

1. Parthenogenetic female, 2. Postabdomen of parthenogenetic female, 3. Ephippial female with ephippium, 4. Male with hook on first leg, 5. Different shapes of labrum, 6. Head shield, 7. First leg of female, 8. Antenna 9. & 10. Ventral marginal setae on valve.

with anterior and posterior corners evenly rounded. Dorso-posterior half heavily chitinized. Height relatively larger than in parthenogenetic female. Carapace around the resting egg heavily pigmented. Ephippium with a single egg.

Male: Length 0.24-0.25 mm. Height rather narrower than in the females (mentioned above). Length-height ratio 10 : 6. Males are characterised by their cigar-shaped antennules which have equal width throughout their length. First leg with a pair of strong copulatory hooks, with a knob-like structure at their bases. Postabdomen broad but smaller in size than in females. Basal spines large, more than half the length of terminal claw. Terminal claw similar but much shorter than that of female.

I thank the Director, Zoological Survey of India, Calcutta for approval of the project, and Dr G.M. Yazdani, Scientist and Officer-in-Charge of this Station, for providing necessary facilities.

September 14, 1991 PRAMOD D. RANE

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31. *BOSMINOPSIS DEITERSI* RICHARD, 1895 — A NEW RECORD FOR WEST BENGAL (CRUSTACEA : CLADOCERA)

(With three text-figures)

During the course of a survey in 1991-92, we came across hundreds of specimens of a cladoceran, *Bosminopsis deitersi* Richard in the river Ganga at Barrackpur, West Bengal (22° N, 88° E). Literature on the cladoceran fauna of West Bengal is scanty. Except for Sharma's (1978) report on the occurrence of about 28 species, there is no other elaborate study for this region. The present study reports the occurrence of *B. deitersi* for the first time.

Family: Bosminidae Sars, 1865

Genus: *Bosminopsis* Richard, 1895

Bosminopsis deitersi Richard 1895 (Figs. 1-3)

Female: Body oval, maximum height near posterior end of the body. Postero-dorsal corner of valves distinct: postero-ventral corner with a small process and with 1-2 spinules before it (Fig. 1). Head rounded with a projection just near the eye, rostrum long with two lateral branches near the apex and a long olfactory seta. Eye large, just touching the anterior margin. Valves with faint polygonal reticulation, ventral margin rounded, slightly serrated and with a long and pointed marginal spine. Post-abdomen small and tapering distally, lateral side with two groups of slightly large denticles followed by groups of fine spinules (Fig. 2). Claw serrated and concave with a bipasal spine. Head shield ornamented with longitudinal and polygonal reticulations (Fig. 3).

Distribution: INDIA: Yamuna river, Delhi (Brehm 1963), Ghana Canal, Keoladeo National Park, Rajasthan (Venkataraman 1987), Irinjalakuda, Kerala (Michael and Sharma 1988), Malaysia (Idris 1983) and China (Seich-chih and Nan-Shan 1979).

Venkataraman (1987) discussed the validity of a new species, *B. devendarai*, described by Rane (1984) from a tank near Jabalpur, Madhya Pradesh, resembling *B. deitersi*. The present study also agrees well with the data given by Venkataraman (1987). The specimens examined by us match the description given by Idris (1983) and Michael and Sharma (1988).

We are grateful to the Director, ZSI, Calcutta for facilities provided to conduct this study.

January 2, 1992 K. VENKATARAMAN
S.R. DAS

Figs. 1-3. *Bosminopsis deitersi,* female. 1. Lateral view, 2. Postabdomen, 3. Head shield.

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32. AN UNUSUAL SPECIMEN OF *TURBINELLA PYRUM* (LINN. 1758)
(With a text-figure)

Fig. 1. Unusual specimen of *Turbinella pyrum* with axial sculpturing.

The Indian chank *Turbinella pyrum* is common on the east coast of India. This species was also recorded earlier from Bombay seas, but has now become rare. Normally the shell is very large, thick and heavy. Inner lip bears three strong folds on the inner margin. Siphonal canal is long and open. Axial sculpturing is completely absent. Young specimens are white with orange spots on the surface; these spots disappear in adult specimens. In the specimen collected, axial sculpturing is very prominent (Fig. 1). This pattern is unusual in *T. pyrum* (L.). The regular pattern of axial sculpturing (varices) is probably a scar created on the mantle edge by an unsuccessful predator.

I thank Dr M.G. Harasewych of the Smithsonian Institution, U.S.A. for help in identification of the shell.

January 21, 1992 DEEPAK APTE

33. FOOD OF THE COMMON MADRAS SNAIL *CRYPTOZONA BISTRIALIS* FROM PT. CALIMERE WILDLIFE SANCTUARY

The common Madras snail *Cryptozona bistrialis* was frequently noticed during the monsoon on the forest floor at the Pt. Calimere Sanctuary, Tamil Nadu. During December 1989, I happened to see this animal devouring vegetable matter from the forest floor. The observed diet included fallen fruits, leaves and parts of grasses and sedges which are listed in Table 1.

It was observed that the short-nosed fruit bat *Cynopterus sphinx* at Pt. Calimere drops chewed remains of fruits and leaves of *Cassia fistula* under their feeding roosts (Balasubramanian, P. 1988, *JBNHS 85* : 183). Such chewed items were also devoured by the snail.

January 21, 1992 P. BALASUBRAMANIAN

TABLE 1

FOOD ITEMS OF COMMON MADRAS SNAIL AT PT. CALIMERE

Species	Family	Part Eaten
Cassia fistula	Caesalpiniaceae	Leaves (dropped by bats)
Canthium parviflorum	Rubiaceae	Fruits (dropped by bats)
Coccinia grandis	Cucurbitaceae	Fallen fruits (pulp)
Trichosanthes tricuspidata	Cucurbitaceae	Fallen fruits (pulp)
Salacia chilensis	Celastraceae	Fallen fruits (pulp)
Prosopis chilensis	Mimosaceae	Fallen pods (pulp)
Spermacoce hispida	Rubiaceae	Leaves
Zornia diphylla	Papilionaceae	Leaves
Bulbostylis barbata	Cyperaceae	Flowers
Dactyloctenium aegyptium	Gramineae	Leaves
Eragrostris viscosa	Gramineae	Leaves

34. FIRST REPORT OF AN ARACHNID ORDER CYPHOPHTHALMI (DA) FROM INDIA IN ARUNACHAL PRADESH

(With five text-figures)

Cyphophthalmi (da) was erected by Simon in 1879 as a sub-order under the order Opiliones (= Phalangida) of the class Arachnida. Savory (1935, 1964, 1977) was the first arachnologist to separate this sub-order and raise it to the level of an order.

Most of the work on these animals is by Juberthie (1961, 1963, 1967, 1968). This interesting group was separated from other opiliones on the basis of : sculpturing of the exoskeleton; nature of body segments; position of eyes (when present); absence of genital operculum; use of spermatophore, tubercles for odoriferous glands, tarsal glands of the males; and anal glands of the males (Savory 1977). Some of the above characters have been illustrated in Figs. 1 and 2.

The Cyphophthalmids are small mite-like (= Notostigmata) arachnids, generally found in caves, under old logs, and in forest litter. Due to their secretive habits and small body size they remain unnoticed and undiscovered from major parts of the world. This order as known has only two families, namely Styllocellidae and Sironidae (Davies 1977). The main character distinguishing these two families is the presence of eyes in Styllocellidae and absence of eyes in Sironidae. The former has 15 genera and the latter 10. The most common genus *Rakia* Hirst (1915-20) has 20 species, mostly from New Zealand, under the family Sironidae (Davies 1977).

There are only two species known from the oriental region. They are reported from Indonesia, viz. 1. *Styllocellus beccarii* (Thorell 1882) (locality: Sereinu, Mentawi Isl.) and 2. *S. weberii* Hans and Soer 1904 (locality : Pangharang, Sumatra) (Roewer 1935). These are the only known localities near the Indian subcontinent. The order was unknown from India until the present collection from Miao (600 m above msl, dist. Tirap, Arunachal Pradesh, north-east India, Coll. Dr. D.B. Bastawade, 6 March 1990).

One mature female of an unknown species was collected 5-6 km north-west of Miao, from under a heavy, decaying log. The specimen was collected along with two Scorpiopsinid (Vaejovidae) scorpions and six Phalangids. This Cyphophthalmid specimen was seen to be distinctly different from those of Phalangids and was slow moving and less sensitive to disturbance at the time of collection.

The female measured 3 mm in total body length, with prosoma (carapace) 1 mm and opisthosoma (abdomen) 2 mm. The integumentary sculpturing was granular but not coarse. Prosoma prominent with a pair of lateral tuberculoid odoriferous gland openings (Fig. 1). The specimen, being totally blind, belongs to the family Sironidae.

The chelicerae are primitive, three-segmented, basal segment narrow, rugose, chela dentate in regular fashion as in Figs. 3, 4. Pedipalps short and slender, apexed with single, minute spine as in Fig. 1. Legs I-IV are seven-segmented, leg formula 4-1-3-2, each apexed with a strong spine. Eight tergites visible dorsally, ninth divided and tucked under ventrally to form rear portion of corona analis (Figs. 1, 2). Nine sternal plates clearly visible, first sternite provided with a pair of shortly elongated stigmata for book lungs or tracheal aperture as in Fig. 2. Coxae of first pair of legs not touching each other medially as in Fig. 2. Third coxa very narrow and compressed between second and fourth coxae (Fig. 2). Genital aperture not distinct. Genital operculum absent.

Distribution: Northern hemisphere: Japan and now reported for the first time from India (Arunachal Pradesh), Austria, Italy, Spain, France and USA (Oregon, Florida and Georgia.). Southern hemisphere : New Zealand, Australia (Queensland) and South Africa. On the Equator : Indonesia, Malaysia, Africa (Guinea), South America (Venezuela). Records from Sri Lanka are not clear.

January 10, 1992

D.B. BASTAWADE

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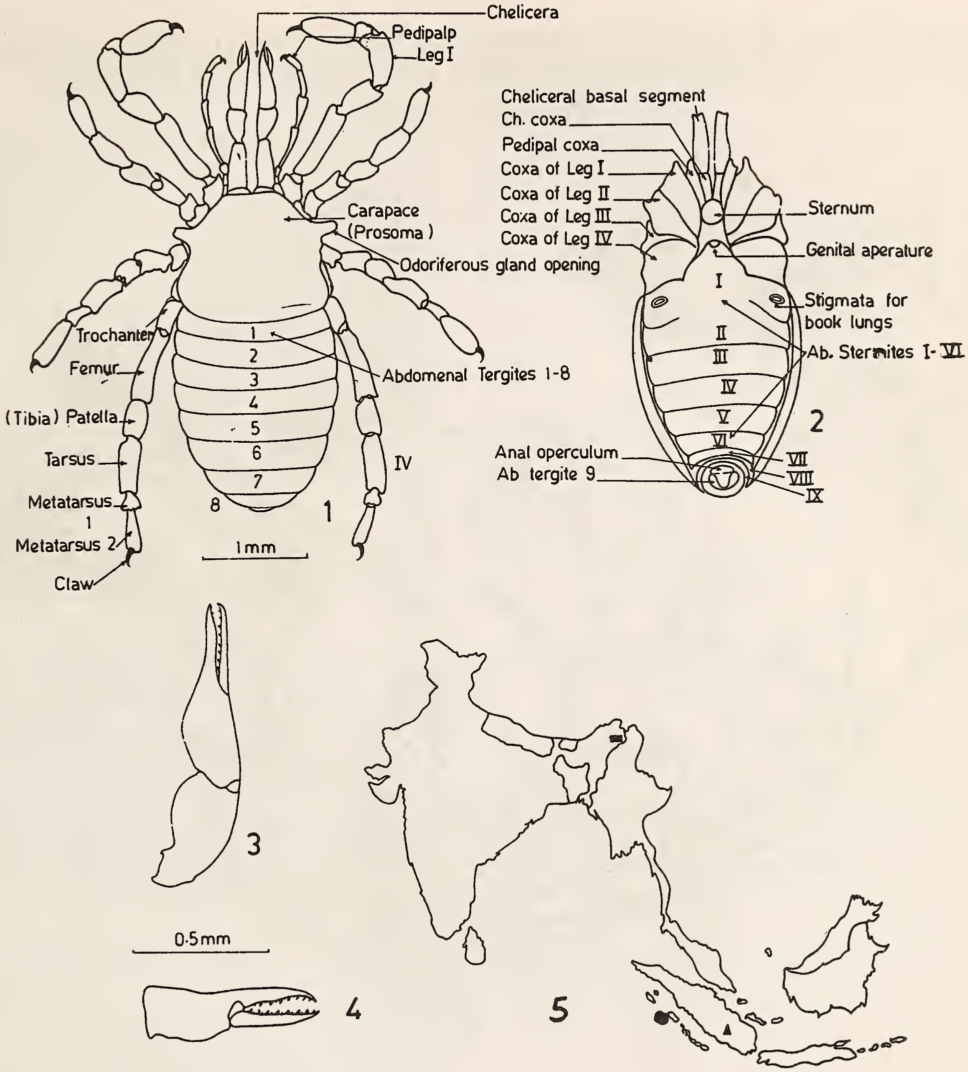

Figs. 1-5. Cyphophthalmid specimen from Arunachal Pradesh.
1. Dorsal, 2. Ventral view of female. 3. Dorsal, 4. Exterior view of chelicera,
5. Distribution of Cyphophthalmida in the oriental region. *Styllocellus beccarii* (Thorell). Mentawi Is. *S. weberii* Hans & Soerr. Sumatra. *Sironid* spp. Tirap, Arunachal Pradesh.

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35. *CROTALARIA SESSILIFLORA* LINN. SSP. *HAZARENSIS* ALI (FABACEAE) — A NEW DISTRIBUTIONAL RECORD FOR JAMMU AND KASHMIR

(With a text-figure)

Fig. 1. *Crotalaria sessiliflora* Linn. ssp. *hazarensis* Ali. A. Habit, B. Flower, C. Pod with accrescent calyx.

While critically examining the herbarium specimens for a revisionary account of the genus *Crotalaria* Linn. some specimens collected by me from Jammu were found taxonomically interesting. On closer laboratory investigation and scrutiny of literature these were identified as *C. sessiliflora* Linn. ssp. *hazarensis* Ali. Besides the report of this taxon from Pakistan (AN ANNOTATED CATALOGUE OF THE VASCULAR PLANTS OF WEST PAKISTAN AND KASHMIR, Steward, R.R. 1972; FLORA OF WEST PAKISTAN, Nasir, E. and Ali, S.I. 1977) the subspecies is known only from a solitary report by M. Sharma (1980, *J. Econ. Tax. Bot. 1:* 170) who published it as a new record for India from Patiala district in Punjab.

C. sessiliflora Linn. ssp. *hazarensis* Ali grows usually concealed by grasses which render its detection rather a matter of chance. Probably for this reason, it was overlooked by B.M. Sharma and P. Kachroo (FLORA OF JAMMU AND PLANTS OF NEIGHBOURHOOD, 1981) during their survey of the Jammu flora.

Since the taxon is common locally along the irrigation channels and other water courses, the present note records its extension as a new addition to the flora of Jammu and Kashmir. As it has not been described in any of our regional Floras, a brief illustrated description is furnished below for easy identification in the field and in the herbarium. The voucher specimens have been deposited in the herbarium of the Regional Research Laboratory, Jammu.

Crotalaria sessiliflora Linn. ssp. **hazarensis** Ali in Biologia, 12 : 27, 1966.

Erect, 15-50 cm tall, annual herb branching usually from the base; stems several, sparingly branched to almost simple, 1-1.5 mm thick, terete to more or less striate, thinly sericeo-pubescent. Leaves oblong to oblong-lanceolate, 1-4 x 0.3-0.7 cm, acute or sub-obtuse, glabrous and punctate on the upper surface, sericeo-pubescent with brown or greyish brown hairs beneath; lateral nerves obscure; petioles silkily villous, 1-2 mm long; stipules setaceous, silkily brown villous, *c.* 1.5 mm long. Flowers bluish, 0.8-1.2 cm. long, 3-8 in terminal and axillary racemes or solitary in the upper axils, reflexed; bracts linear- lanceolate, 4-5x0.75 mm, glabrous on the ad-axial surface, silkily villous abaxially; bracteoles two, linear-lanceolate to subulate, *c.* 3x0.75 mm, glabrous adaxially, villous abaxially.

Calyx 0.8-1.2 cm long, 2-lipped, 5-lobed nearly to the base, glabrous within, pilose without; lobes acute, upper two broadly oblong-lanceolate, lower three narrow, linear-lanceolate. Corolla included, shorter than to just equalling the calyx. Pod inflated, obovate-oblong, sessile, 1-1.2 cm long, glabrous. Seeds 8-10, reniform, yellowish or brown, 1.75x1.75 mm.

Habitat: Hidden among grasses along the banks of irrigation channels and other water courses in low lying areas; common.

Flowers: September-October. **Fruits:** October-November.

Distribution: Pakistan. INDIA: Punjab, Jammu.

Specimens examined: Phulain village (*c.* 300 m) *B.M. Sharma* 50232; Sumh village (*c.* 300 m) *B.M. sharma* 50233; Suren Chak (-) *B.M. Sharma* 51490; Danga village (-) *B.M. Sharma* 51491.

I thank the Director, Dr. R. S. Kapil, for his interest and encouragement and Dr. Y.K. Sarin, Chairman, Botanical Sciences Discipline for his valuable suggestions.

December 17, 1991

B.M. SHARMA

36. FORMATION OF ABNORMAL FRUIT IN *CARICA PAPAYA*

Carica papaya (Hindi name Papita) is a common fruiting plant grown throughout the country for its nutritious fruits. Fruits are thick in the middle and tapering towards the poles. The fruit is a berry which develops from multicarpillary, syncarpous ovary. A plant growing in our house bears several normal and one abnormal fruit. It is trifurcated like a palm with three fingers. Three fingers are united at the base up to 1.25 cm.

The abnormality is due to apocarpy (carpels becoming independent instead of fused) and the fruit is an excellent example of an aggregate fruit. Neither condition has been reported so far in this plant. The fruit is of normal size but remains seedless.

May 29, 1991

S. SINGH
S.P. SINGH

37. *ACTINODAPHNE SESQUIPEDALIS* (LAURACEAE) – A NEW RECORD FOR INDIA FROM ANDAMAN ISLANDS

(With nine text-figures)

From the plant collections made during the botanical exploration in Mount Harriet hill ranges (South Andamans), an interesting *Actinodaphne* species was collected from the southern hill slopes of Shoal Bay area. After critical studies the specimen was identified as *Actinodaphne sesquipedalis* (Wall. ex O. Ktze.) Hook. f. & Thoms. ex Meissn., hitherto not known from India. This species was earlier known from Tenasserim and Penang.

Actinodaphne Nees includes 60-70 species (Airy Shaw 1973). The genus is distributed in Indo-Malaysia and east Asia. 15 species have been reported for India (Santapau and Henry 1973). Vasudeva Rao (1986) listed two species, viz. *Actinodaphne madroptera* Miq. from Andamans and *A. procera* Nees from Nicobars. To facilitate identification, a detailed description of the plant along with nomenclatural citation, distribution and figures is given below.

Actinodaphne sesquipedalis (Wall. ex O. Ktze.) Hook. f. & Thoms. ex Meissn. in DC. Prodr. 15(1): 216. 1864; Hook. f., Fl. Brit. India 5: 151. 1886; Gamble, Man. Ind. Timb. ed. 2: 569. 1902; Brandis, Ind. Trees 535. 1906; Ridley, Fl. Mal. Pen. 3: 107. 1924; Kosterm., Bibl. Laurac. 40. 1964. *Laurus sesquipedalis* ex O. Ktze., Rev. Gen. Pl. 2: 570. 1891 (Figs. 1-9).

Trees, 8-10 m high; bark smooth; young branches woolly tomentose; terminal bud scales 0.2-2.0 x 0.4-1.0 cm, semi-orbicular to oblanceolate, acute at apex, obtuse at base, woolly, brownish, tomentose without, glabrous within. Leaves 23-40 x 9-21 cm, whorled, elliptic or oblanceolate, coriaceous, coppery brown when dry, glossy, puberulous or glabrescent above, subglaucous beneath, acute to acuminate at apex, cuneate or rarely oblique at base, entire at margins, midrib flat and glabrous above, impressed and woolly tomentose beneath, lateral nerves 10-15 pairs, running obliquely towards margins, slightly impressed and glabrous above, impressed and woolly tomentose beneath, secondary nerves lax, scalariform and faint above, prominent beneath, tertiary nerves faintly visible on both sides; petioles 2.5-4.0 cm long, stout, woolly tomentose. Inflorescences cauliflorous, rarely axillary.

Flowers unisexual, golden brown, in peduncled clusters, each peduncle bearing bracteate umbellules of 4-5 sessile to shortly pedicelled flowers, peduncles *c.* 0.5 cm long, golden brownish tomentose; involucral bracts 4, *c.* 0.3 x 0.2 cm, elliptic, golden brownish tomentose without, glabrous within; perianth *c.* 0.5 x 0.4 cm, in two rows, golden brownish tomentose without, glabrous within; staminodes 13-15, *c.* 0.1 x 0.05 cm, ovate or glandular, shortly stalked with a few long hairs intermingled with numerous hairs projecting from torus; ovary *c.* 0.2 x 0.05 cm, solitary, flask-shaped, with a few long hairs on one side, slightly sunken in torus, style horse-shoe shaped, stigma capitate.

Flowers: May.

Distribution: Tenasserim; Penang; INDIA: South Andamans.

Specimen examined: South Andamans, Shoal Bay (Mount Harriet hill range), 16 May 1990, *Sam P. Mathew* 20503 (*PBL*).

Ecology: Rare in inland evergreen forests.

We are grateful to Dr B.D. Sharma, Director, Botanical Survey of India, Calcutta for facilities. Thanks are due to Dr N.P. Singh, Ex-Regional Botanist, Royal Botanic Gardens, Kew for confirming the identity of the plant; to Dr. P.S.N. Rao, Scientist – 'B'– In-charge, Botanical Survey of India, Andaman and Nicobar Circle, Port Blair for encouragement and to the authorities of South Andaman Forest Division for extending cooperation during field studies.

SAM P. MATHEW
May 27, 1991 P. LAKSHMINARASIMHAN

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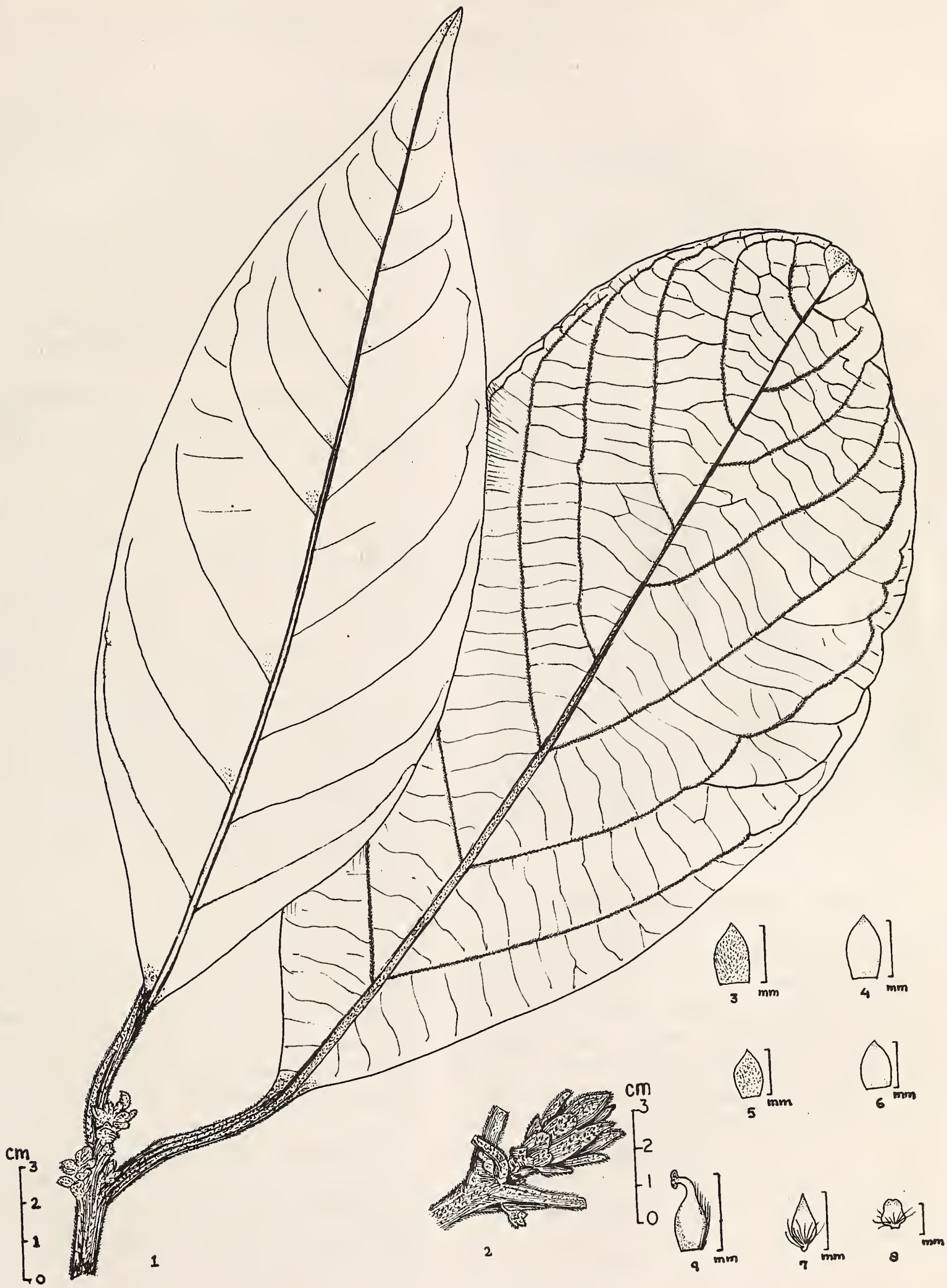

Figs. 1-9. *Actinodaphne sesquipedalis* (Wall. ex O. Ktze.) Hook. f. & Thoms. ex Meissn.
1. Habit, 2. Terminal bud scales, 3. Bract (dorsal view), 4. Bract (ventral view), 5. Perianth (dorsal view), 6. Perianth (ventral view), 7 & 8. Staminodes, 9. Ovary.

38. *MAPANIA KURZII* CLARKE (CYPERACEAE) — A NEW RECORD FOR INDIA
(With a text-figure)

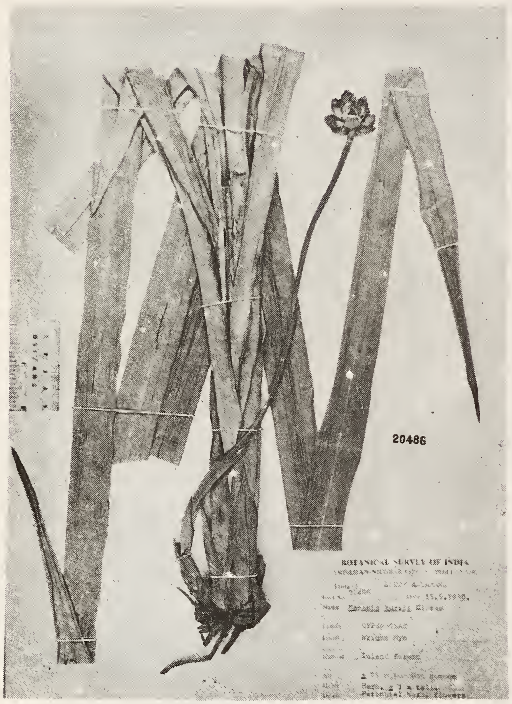

Fig. 1. *Mapania kurzii* Clarke.

The genus *Mapania* Aublet consists of over 45 species (Koyama 1985) distributed mainly in the tropical regions of South America, Africa (excluding Madagascar), Sri Lanka, Assam, Sylhet, Thailand and Indo-China, West Pacific, North Queensland, Malay Peninsula, Sumatra and West Java. Kern (1974) in his revision on the Malesian Cyperaceous genera, recognised three different sections under this genus with over 27 species.

This pan-tropic genus is represented in India by four species, viz. *M. cuspidata* (Miq.) Uittien, *M. kurzii* Clarke, *M. palustris* (Hassk. ex Steud.). F. Vill. and *M. zeylanica* (Thw.) Benth. ex Clarke, of which *M. kurzii* is recorded here as an addition to the Indian flora. Thothathri *et al.* (1972) reported the occurrence of *M. cuspidata* var. *angustifolia* (Uittien) in the Nicobar group of islands. Though Hooker (1894) included *M. kurzii* in his FLORA OF BRITISH INDIA, the distribution given by him is only as Malacca and Penang.

While working on the flora of Mount Harriet at the South Andaman islands, one of us located a few populations of this sedge from the inland forests. This being the first record of its occurrence in India, a detailed, illustrated account is provided here to facilitate identification of this extremely rare plant.

Mapania kurzii Clarke in Hook.f., Fl. Brit. India 6: 681. 1894; Ridley, Fl. Malay Pen. 5: 172. 1925; Kern, Fl. Malesiana 7 (3): 478. 1974.

Perennial herbs. Stems 40-120 cm high. Leaves linear, narrowed at base, attenuate and triquetrous at apex, aculeate-scabrous at margins, 40-120 x 1-3 cm, coriaceous, median nerve prominent, lateral two nerves indistinct. Sheaths keeled, stramineous with pale brown, scarious margins.

Scapes lateral, trigonous, smooth, 12-50 cm x 1-3 mm, base with lanceolate sheaths. Inflorescence capitate, with 4-8 spikelets. Involucral bracts ovate-lanceolate, 1.5-3 x 1 cm, many-nerved, coriaceous with scarious margins. Spikelets ovoid or ellipsoid, 1.5-3 cm x 8-10 mm. Sterile glumes ovate, obtuse at apex, 1-1.5 cm x 5-8 mm, coriaceous, many- nerved. Fertile glumes ovate, obtuse or rounded at apex, 8-10 x 5-6 mm, coriaceous, 3-7-nerved.

Florets slightly longer than the fertile glumes. Outer two scales boat-shaped, winged and ciliate along the keels, 8-10 x 1-1.5 mm, chartaceous. Inner four scales linear, concave, 2-keeled, 8-10 x 1 mm, delicate, hyaline. Stamens three, linear, 2-3 mm long. Ovary linear, 3-4 mm long; styles 4-6 mm long; stigmas 3, 3-4 mm long. Nuts not seen.

Flowers and fruits: May-June.

Very rare, in mixed deciduous forests of Wright Myo area, at an altitude of ±75 m, in sandy loam, often associated with *Thottea tomentosa* (Blume) Ding Hou.

The juvenile shoots of this plant, with its peculiar linear, tough, coriaceous leaves with aculeate-scabrous margins show a superficial resemblance to some species of *Pandanus* L. ex St., in the forests.

The leaves have a very distinct median nerve and two in conspicuous lateral nerves, which is contrary to the description given in the protologue and also by Kern (loc. cit.). Similarly, the foliar bracts of the inflorescence also show a quantitative variation. More specimens are needed for further critical study of this rather rare species.

Specimens examined: INDIA: South Andaman, Mount Harriet hill ranges, Wright Myo, 15 May 1990, *S.P. Mathew* 20486 (PBL).

We thank Dr (Miss) Veena Chandra, Forest Research Institute, Dehra Dun for examining the specimen; Dr. B.D. Sharma, Director, Botanical Survey of India, Calcutta for encouragement; and N.G.R. Nair, Botanical Survey of India, Coimbatore for neatly typing the manuscript.

October 16, 1991

SAM P. MATHEW
P.V. SREEKUMAR

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39. NEW DISTRIBUTIONAL RECORDS OF *BRACHIARIA HYBRIDA* BASAPPA & MUNIYAMMA (POACEAE)

(With a text-figure)

During the course of studies on the grasses at the Central National Herbarium (CAL), we have noted new distributional areas of the species *Brachiaria hybrida* described by Basappa and Muniyamma in 1983.

Brachiaria hybrida Basappa & Muniyamma in Proc. Indian natn. Sci. Acad. B 49 No. 5. pp. 377-389. 1983.

Type: Holotype CAL; Isotype MH, BSI, BSJO, MGM.

After checking the herbarium specimens of *Brachiaria milliformis* (Pres) A. Chase and *Panicum distachyum* L. deposited in CAL the following specimens appeared to be *Brachiaria hybrida* due to the unequal leaf bases; panicle with single raceme; pedicel with 1-2 long white hairs (some specimens are with 1-3 long white hairs) and the absence of palea in the lower floret.

Andaman: Great Cocos Islands, 1889, *D. Prain s.n.*, Herb. acc. nos. 520317 & 520318; South Andaman, *S. Kurz s.n.*, Herb. acc. no. 5?0319.

Assam: Upper Assam, 1841, *J.D. Hooker s.n.* Herb. acc. no. 520311; Dibru Valley, 1850, *Coll.*?, Herb. acc. no. 520308.

Bihar: Mongher, 1894, *Mokim* 1436.

Tamil Nadu: *Coll.* ? 47.

West Bengal: Santiniketan, July 1956, *B.K. Das s.n.*, Herb. acc. no. 520296; Gorumara, 7 January 1956, *P.C. Nanda s.n.*, Herb. acc. no. 520275; Centre of Golapbag, Burdwan, 28 November 1966, D.K. Banerjee 4835; loc?, Coll.?, Herb. acc. no. 520290.

Flowers and fruits: April - September

So far, this species was known only from its type locality, Shimoga district of Karnataka (Basappa and Muniyamma 1983). The examination of herbarium sheets as noted from Bihar, West Bengal, Assam, Tamil Nadu and Andaman Islands show that *Brachiaria hybrida* occurs in south and east India and in the Andaman and Nicobar Islands.

We are grateful to the Director and Joint Director (CNH), Botanical Survey of India for all facilities for the study.

August 20, 1991

PAPIA MONDAL
D.C. PAL

Fig. 1. *Brachiara hybrida* Basappa & Muniyamma.
A. Habit (drawn from type material), B. Upper surface of spikelet, C. Lower surface of spikelet, D. Opened spikelet – a. Lower glume, b. Upper glume, c. Lemma, d. Lemma of upper floret, e. Palea of upper floret, f. Gynoecium, g. Anthers.

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NEW DESCRIPTIONS

MISCELLANEOUS NOTES

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ON THE ENDANGERED INDIAN TROUT *BARILIUS BOLA* (HAM.)[1]

C.V. KULKARNI[2]

(With a text-figure)

The Indian trout *Barilius bola* (Ham.) is well known as one of the finest food and game fishes of India. It is presently rather rare in its natural habitat. The conservation of mahseer has fortunately begun to receive attention all over India, but lamentably, the Indian trout has not received equal attention and may become extinct. It is, therefore, essential that extensive biological and ecological investigations should be undertaken to determine the areas where the fish is still surviving and devise ways and means to conserve the species, before it is too late.

NOMENCLATURE

Considering the sporting qualities and also the shape of the body, mouth and the colour of *B. bola,* British anglers synonymised it with the trout, but to distinguish it from the real trout of their country, they called it the Indian trout of family Cyprinidae. Taxonomically it has no relation with the real trout which belongs to a different family, Salmonidae, and does not naturally occur in India. Indian trout is not the only fish which is erroneously associated with the name 'trout'. The so-called snow trout and hill trout (Tilak and Sharma 1982) are two other examples of such erroneous association. These two, belonging to sub-family Schizothoracinae, are also taxonomically far apart from the family of the real trout. Why these bottom-dwelling forms are awarded the honourable suffix 'trout' is not clear.

The scientific name of the Indian trout has also gone through several changes. Hamilton (1822) originally described the fish as *Cyprinus bola* but McClelland (1839) named the genus as *Opsarius.* Day (1878) designated the fish as *Barilius bola* (Ham.). Surprisingly, Jordan (1918) preferred to perpetuate its Assamese local name 'Rajahmas' by renaming the fish as *Raiamas bola*, based on the characteristics of the cleft of the jaw. Hora (1937), however, accepted McClelland's change, but put the new generic name as a subgenus giving the fish a longer name *Barilius (Opsarius) bola.* Later, Day's nomenclature was again approved by several other authors (Menon 1974, Jayaram 1981). However, the latest preference seems to be for 'Raiamas' following the contention of Howes (1980). Despite all these changes, I have, in this paper, followed Day's terminology, as it is the one that has been commonly used for more than a century.

Like the confusing taxonomic position of the Indian trout, its local names too are numerous. Though Hamilton took the Bengali

[1]Accepted June 1992.
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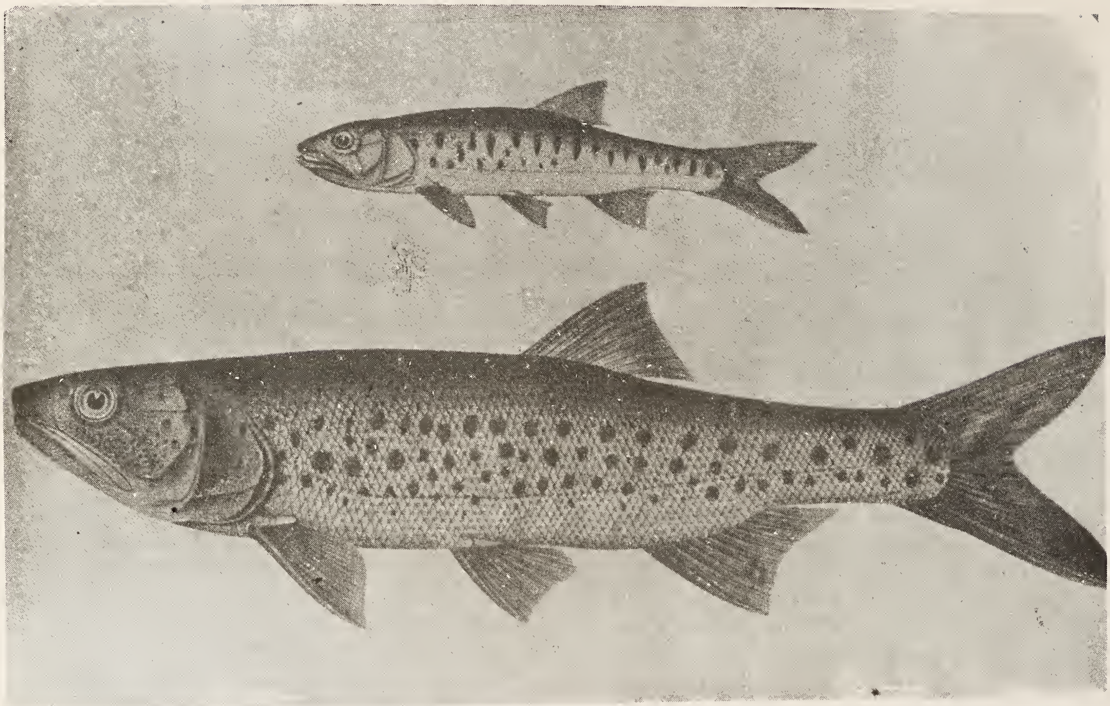

Fig. 1. Indian trout *Barilus bola* (Ham.).

name 'bola' as its specific name, 'goha' is also its alternate name in the same region. Its Hindi and Oriya equivalents are 'buggarah' or 'buggah' but in Uttar Pradesh it is referred to as 'gulabi machchhi'. In Assam it is known as 'korang' and also as 'rajahmas'. Recent findings indicate that fishermen at Jawad near Neemuch and Rampura on the Gandhi Sagar reservoir (both in Madhya Pradesh) call the fish 'gallar.'

Distribution and morphology: Day, following Hamilton's account, mentioned the geographic distribution of the fish as Bengal, Orissa, Assam, North-West Provinces, Nepal and Burma. But its occurrence in Jamuna, Chambal, including its tributaries and lakes and streams of Rajasthan was not recorded in scientific literature till its mention by Evans (1926).

Like the real trout, Indian trout is morphologically an elegant, small, streamlined fish about 30-40 cm in length and is equally appreciated as a table fish. Day (loc. cit.) reports capture of the fish in Assam up to 5 lbs in weight, whereas McDonald (1948) confirms having caught fish up to 3 lbs in Burma. Fishermen at Rampura affirm that the fish normally attains a weight of 1 kg. Even at this low weight the fish is admirable as food as well as for sport. Its silvery colouration with spots on either side of the body is quite attractive, with pink coloured fins, the lower lobe of the caudal being brighter and edged with a black line. Spots on the sides become more outstanding only in preserved specimens. The sub-terminal jaw and large eyes add to the attractiveness of the fish (see Fig.1).

Sporting qualities: As a sport fish, its qualities are *par excellence.* It takes fly or any other shining bait as quickly or even more quickly than the European trout. It was observed that if a bait or even a piece of white cloth tied

to a rod and line is moved over the surface of water where the fish exists, it follows the bait and tries to snap it when close enough. Evans (1926) in a letter published in 1831-32 in the Oriental Sporting Magazine (U.K.), recorded occurrence of the Indian trout in great abundance near Neemuch, where the British Army was stationed. The officers of this station enjoyed every week-end, the enviable treat of catching dozens of Indian trout in a couple of hours on artificial fly, on the banks of the Chambal river. The letter also quoted a record of "the enormous number of 51 dozens of fine trout" caught in a day's fishing by three anglers. On another occasion 19 dozen per head were landed by two anglers. Such was the tremendous voracity of the fish and also its astounding abundance in rivers in those days. Thomas (1897) also commented on the sprightly behaviour of the fish in north Indian rivers.

Transplantation: Despite these wonderful sporting qualities, the fish at present is sadly neglected. Because of its piscivorous habit, it was not considered as a cultivable species and hence was completely ignored; so much so that it is almost driven to extinction and the Directorates of Fisheries hardly know anything about the species. Considering this serious situation, it was decided to study its ecological requirements and spawning behaviour. Based on the information available through Evans (1926) and the cooperation of the Director of Fisheries, Madhya Pradesh and his officers, a small number of fingerlings were collected from a stream near Jawad (a neighbouring village of Neemuch) in November 1974 and brought to Lonavla (dist. Pune), which had incidentally the same altitude as Neemuch (Kulkarni 1975). After growing the fingerlings in a nursery pond for about five months, they were released into the nearby Walwhan reservoir, having a waterspread of about 560 ha. Two years later they were observed to breed near the small feeder streams of the lake. A small batch of fingerlings was grown in a pond for further studies.

Biological account: The fish is piscivorous and rarely touches the conventional groundnut-oil cake or rice polish, but pounces avidly on small loaches, chilwa and even small berils. Mosquito larvae and other insects appeared to be their favourite food in early stages. They followed even the butterflies hovering over the surface of the water. In short, they went after everything that was alive. Dead fish and green algae were left alone. By nature it is largely a riverine fish, frequenting shallow marginal waters for hunting small fishes. In lacustrine conditions it inhabits upper columns of lake waters and the marginal areas to facilitate feeding on live matter. However, the rapacious nature of the fish indicates that it might take to artificial feed of animal origin, especially small pieces of dry fish soaked in water, after some amount of training as in the case of murrels.

Like the major carps, *B. bola* breeds in the early part of the monsoon when the rivers and streams are flooded with fresh rainwater. Observations made during breeding of the fish in confined water (ponds) indicated that it matures in the second or third year. Other significant findings were that though there was no sexual dimorphism, the male assumes brighter nuptial colours and develops bright spots and tubercles on its opercular portion. Another feature is that the scales of the male on both sides of the body develop tubercles or warts which make the body rough to touch. This enables identifying the sex by merely touching the fish without taking it out of the water. Tubercles and the opercular spots disappear after the breeding season. The body colours also decrease in brightness.

The characteristics of the eggs, their hatching and larval development have been studied by Kulkarni and Ogale (1978). It was observed that though the fish does not naturally breed in ponds, it responds to hypophysation (breeding with the help of pituitary hormone injections). Hence multiplication of the species on a large scale will not be difficult. Its spawning behaviour in natural streams has not so far been

reported except for observations made at the feeder streams of the Walwhan reservoir. Nevertheless, on the basis of these observations it can be assumed that the fish does not require special conditions for spawning except clear (clean) running water of streams and warm (26°-28°C) temperature for hatching of eggs, which are much more delicate than those of major carps.

Depletion: Not being a specialised fishery, the extent of depletion of the fish cannot be statistically ascertained for lack of species-wise estimates of its production. But the general information I have gathered through personal correspondence as well as direct conversation during fisheries seminars, have unquestionably shown that the fish has become rare and is not even noticed by fishery workers (especially from north Indian states). Dr. A. G. K. Menon of the Zoological Survey of India informed me in a personal communication that the fish was really endangered. He has included it in his list of endangered species. Biologists cannot wait for any further proof of depletion of an entirely aquatic animal which cannot normally be seen or make its presence or absence felt by any means. Even crocodiles are better off in that respect. It is essential, therefore, that fishery biologists should note the possibility of extinction of this outstanding fish and take early steps for its survival.

The causes of depletion are largely the countrywide pollution of our waters by different types of effluents and the pressure of population seeking increased quantity of fish as food. Eggs of this fish being more delicate and requiring more oxygen during hatching, compared to ordinary carps, are mortally affected by polluted waters. Added to that is the indiscriminate killing of brood and juvenile fish by the fishermen themselves through ignorance. Unfortunately many other freshwater fishes also are meeting the same dismal fate.

Action plan for conservation: Although the need for conservation of the species has thus been established, the appropriate agency to tackle the problem and take the necessary steps for conservation requires to be identified. In my opinion State Fisheries departments instead of restricting themselves to a few cultivable species, should expand their horizons and cultivate this excellent table fish, as is recommended for murrel culture. Moreover, some states would like to have in the lakes of their hill-stations some trout-like popular game fish to attract tourist traffic. Research institutes under the I.C.A.R. (Indian Council of Agricultural Research) should therefore sponsor a few projects for more intensive biological and ecological investigations on the fish in its natural habitat, namely, the streams and rivers in northern India, and consider ways and means to conserve the fish. Universities in the same region could also undertake short-term projects under the sponsorship of the U.G.C. (University Grants Commission) to study the biology of the fish in detail. The I.C.A.R. can as well utilise their Agriculture cess-funds for this purpose, for sponsored research projects.

In the meanwhile, regional angling associations should arrange to have fingerlings of the fish collected and stock their protected waters to verify and confirm its reputation as an extraordinary game fish. Especially, central organisations like the Angling and Aquatic Conservation Society of India should undertake breeding the fish in their fish farm, if any, and distribute fingerlings to other waters, so that it can be perpetuated for the benefit of future generations. Financial assistance from the Ministry of Environment & Forests could also be sought for the above purpose at Bhadkhol or any other suitable reservoir. Enlightened private sector units like the Tata Electric Companies which have done such commendable work for the conservation of the mahseer should divert their efforts to the Indian trout also.

Hora (1937) had given an exhaustive account of the species but unfortunately no attention was thereafter drawn to the problem of its depletion and need for conservation. However,

ecological and socio-economic conditions in India have changed during the past four or five decades. It is, therefore, only by an all-out effort that more information can be collected about the Indian trout and the measures required taken for its conservation. If crocodiles can be protected, the Indian trout has a greater claim, but a complete ban on killing the fish is not recommended for various reasons, largely because we want to protect the fish as well as the fisherman.

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BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS – PART XIII – MALE REPRODUCTIVE PATTERNS IN THREE BATS[1]

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(With a plate and four text-figures)

Male reproductive rhythm is reported in three species of Indian bats, namely *Rousettus leschenaulti, Hipposideros fulvus fulvus* and *Pipistrellus ceylonicus chrysothrix* from Aurangabad by examining the testes and accessory glands throughout the year. Males of *R. leschenaulti* have a long sexual season extending from October to the end of March, when they retain their copulatory competence. Males of *H. fulvus fulvus* come to sexual activity in a sharply defined period during November. Males of *P.c. chrysothrix* are sexually active from the first week of June to the second week of July. While males of *P.c. chrysothrix* attain sexual maturity within the year of birth, males of the other two species reach sexual maturity in 14 to 19 months. External factors do not seem to play a significant role in the onset of breeding activity.

Introduction

Most reports on the breeding behaviour of Indian bats are based on the examination of females (see Gopalakrishna and Sapkal 1986 for detailed bibliography) with a view to identifying the breeding season(s) on the basis of pregnancy record. Studies on the sexual rhythm of males have not been made except in two Indian bats, namely *Scotophilus temmincki (S. wroughtoni)* (Gopalakrishna 1948, 1949) and *Rhinopoma microphyllum kinneari* (*R. kinneari*) (Kumar 1965). In both these species the sexual rhythm is synchronous in the two sexes and hence, pregnancy record can be taken as the criterion for determining sexual periodicity. However, there are many species in which this can be deceptive because of considerable time lag between copulation and ovulation. In such cases the study of the sexual rhythm in males becomes essential for determining reproductive behaviour. We chose to study the males of *Rousettus leschenaulti* (Pteropodidae), *Hipposideros fulvus fulvus* (Hipposideridae) and *Pipistrellus ceylonicus chrysothrix* (Vespertilionidae) as they represent widely different families, exhibit different patterns of reproductive activity and bear different relationships to the sexual rhythm of the females. All the species were examined from the same geographical region.

No attempt is made here to describe the anatomy of the male genitalia of these species since this has already been reported (Gopalakrishna and Murthy 1976, Murthy 1971).

Material and Methods

The specimens of the three species were collected at and around Aurangabad (19° 53′ N, 75° 25′ E) in Marathwada region of Maharashtra. *H. f. fulvus* and *P. c. chrysothrix* are house bats inhabiting dark humid recesses of old houses, grain godowns and cow-sheds. A few specimens of *H. f. fulvus* and *P. c. chrysothrix* were collected at Nanded (19° 9′ N, 77° 20′ E) about 130 km south-east of Aurangabad and the condition of the genitalia of these specimens was similar to that of the Aurangabad specimens. A large colony of *R. leschenaulti* occurred in an underground tunnel near Bibi-ka-Mukbara in Aurangabad.

Specimens of all the species were collected randomly during 1964-1966 and 1976-1979, with at least one collection every calendar month (Table 1). The body weight of every

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specimen was recorded after killing by chloroform and the male genital organs were dissected out and immersed in alcoholic Bouin's fixative. After 24 hours of fixation the tissues were transferred to 70% ethanol. The right testis of each specimen was weighed in a Mettler balance after rolling the testis a few times on a filter paper to remove the excess fluid on the surface of the testis. Paraffin-embedded testes and accessory glands of selected specimens from each month's collection were sectioned at 10μ thickness. The section were stained with Ehrlich's haematoxylin and counterstained with eosin after following the usual procedure and mounted in DPX.

Interstitial cell counts were made following the method adopted by Gopalakrishna (1949).

Observations

Rousettus leschenaulti

This species breeds twice a year in quick succession (Gopalakrishna 1964, Gopalakrishna and Choudhari 1977). The first cycle commences in November-December and deliveries in the colony occur during March-April. The second cycle commences within a few days after parturition and deliveries occur during the latter half of July. Each female delivers a single young one during each cycle. The lactation period of the first cycle overlaps the early gestation period of the second. Females are sexually quiescent from August to the first week of November.

The newly born young male weighs 12 ±1 g. During the suckling period, which lasts for 35 to 40 days, the young one grows rapidly and attains a weight nearly three times its weight at birth. All specimens weighing more than 73 g are sexually mature and the specimens attain this weight at the age of 14-15 months (Gopalakrishna and Choudhari 1977). All specimens having a testis weight of 100 mg and over were sexually mature. The testis weight of adult animals does not fall below this even during the sexually quiescent period. Hence, apart from body weight, the weight of the testis can also be taken as a valid criterion for determining sexual maturity in this species.

Fig. 1 gives the relative increase in body weight and testis weight. This reveals some interesting features. The weight of the testis of the newly born young is 12 mg. By the time the body weight reaches 60 g (nearly five times the weight at birth) the weight of the testis reaches 20 mg — a little over 1.5 times the weight at

Table 1

MONTHWISE COLLECTION OF MALE SPECIMENS OF THREE SPECIES OF BATS

Month	*Rousettus leschenaulti*			*Hipposideros fulvus*			*Pipistrellus ceylonicus*		
	Immature	Adult	Total	Immature	Adult	Total	Immature	Adult	Total
Jan.	12	61	73 (6)	1	15	16 (7)	4	20	24 (9)
Feb.	19	43	62 (4)	—	5	5 (4)	—	10	10 (5)
March	7* + 18	43	68 (6)	1	5	6 (6)	—	23	23 (7)
Apr.	38* + 19	52	109 (9)	4	4	8 (3)	—	20	20 (5)
May	3* + 13	30	46 (7)	15 + 20	16	51 (6)	—	36	36 (12)
June	23	15	38 (5)	5	18	23 (4)	—	42	42 (14)
July	2* + 8	9	19 (3)	1	9	10 (2)	—	56	56 (16)
Aug.	1* + 3	13	17 (3)	1	11	12 (4)	4*	25	29 (15)
Sept.	7	22	29 (5)	—	10	10 (4)	62* + 11	12	85 (20)
Oct.	1	8	9 (2)	15	17	32 (5)	2* + 21	19	42 (10)
Nov.	23	45	68 (8)	—	19	19 (5)	9	22	31 (9)
Dec.	24	46	70 (6)	4	8	12 (6)	6	16	22 (7)
Total	51* + 170	387	608	19* +48	137	204	68* + 51	301	420

*Indicates number of sucklings in the month. Numbers in parentheses indicate the number of collections made during the respective month.

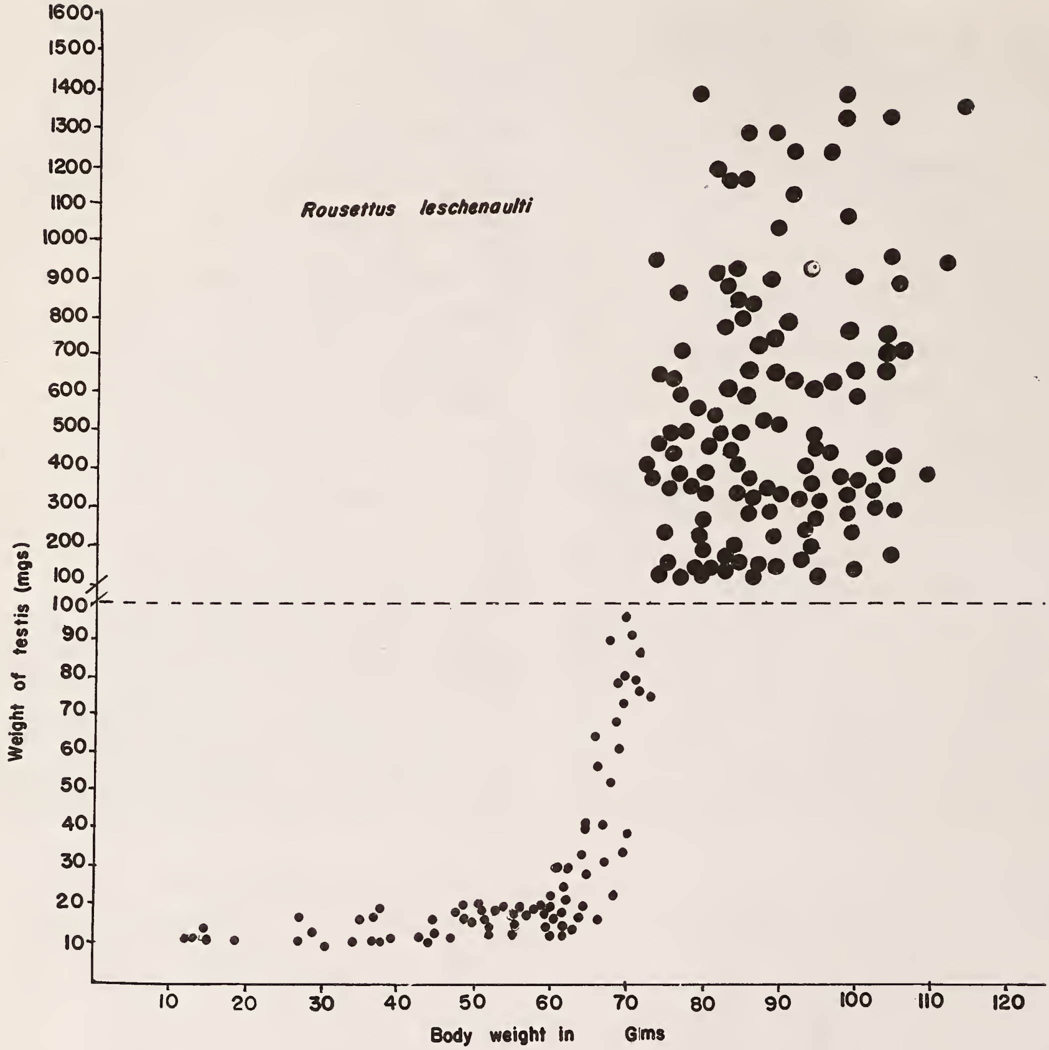


Fig. 1. Scatter diagram showing relationship between increase in body weight and weight of testes in *Rousettus leschenaulti*. The discontinuous line denotes weight at sexual maturity. See text for descriptions.

birth. After this stage until sexual maturity, the increase in body weight is only 13 mg (about 20%), whereas the testis attains a weight of 100 mg (an increase of nearly 500%).

During the sexually active season the colony contains a few immature bats (Plate 1, Figs. 5-9). This indicates that the animals do not attain sexual maturity within the year of their birth. During November to February the animals could be recognised as two distinct groups on the basis of testis size (Plate 1, Figs. 5-7), thereby indicating that the juveniles were nearly of the same age — and were most probably born during the previous breeding season. It was, however, not possible to distinguish the animals born in February-March from those born the

previous July. But from March onwards (Plate 1, Figs. 8, 9) three distinct groups of animals could be identified on the basis of testis size — those born in February-March of the year, those born during February-March and July of the previous year and adult animals, which were at least 20-24 months old.

Fig. 2 shows the weight of the testis of adult animals during the different months of the year. Testis weight is low during April to September, then increases suddenly during October-November. It falls a little during December-January, but not to the level as during April to September. There is a second rise during February and March, but this is not to the same peak as during November-December.

The testis does not exhibit any spermatogenetic activity from April to September. During October and November the seminiferous tubules become wider and there is a sudden spurt of spermatogenetic activity, and the lumen of the seminiferous tubules contains spermatozoa in large numbers. During December and January, although spermatogenetic activity continued, it was considerably less vigorous. A second spurt of spermatogenesis occurs during February and March, after which there is complete cessation of spermatogenesis until October.

Fig. 2 also includes a scatter diagram giving the total number of interstitial cells in the adult testis during different months of the year and the curve illustrates the variations in the number of these cells during the year. The curve has two peaks of activity closely parallelling those of the changes in the weight and spermatogenetic activity in the testis. The cauda epididymis is full of spermatozoa and the accessory glands are in a high state of activity from October to the end of March. Evidently, the changes in these structures are synchronous with the activity of the testis.

Hipposideros fulvus fulvus

This species breeds once a year in a sharply defined season (Madhavan *et al.* 1978). Copulation followed by conception occurs in all adult females in the colony in the middle of November and each female delivers a single young one between 23 April and 7 May.

During the breeding season the colony contains some immature males with juvenile testes and accessory glands. This indicates that males do not attain sexual maturity in the year of birth although they reach adult body weight within 7-8 months of age. Since the condition of the male genitalia of all the juvenile specimens was similar, it is evident that they are all nearly of the same age. This also indicates that animals born during April-May attain sexual maturity by the following September and participate in copulation in November, when they are about 18-19 months old.

The testis weight of adults during the different months of the year is given in Fig. 3. The testis weight remains low until September when it suddenly increases, reaching its maximum in October, then falls to low values in February. During the sexually quiescent period the testis weight of adults falls below the testis weight of animals approaching adolescence.

Microscopic examination reveals that the testis of adult animals present a typical regressed picture from January to about the end of August. The seminiferous tubules are small in diameter with narrow lumina. The germinal epithelium is composed of a layer of resting spermatogonia which do not exhibit any division stages. A loose parenchymatous connective tissue with mostly fusiform cells and a few clusters of interstitial cells occur in the intertubular areas. The testis is quiescent until August when it suddenly spurts into spermatogenetic activity which occurs vigorously during September, October and November. During this period the seminiferous tubules increase in diameter and have all stages of spermatogenesis. The cauda epididymis is full of spermatozoa during September to December, when the accessory glands are also in a state of intense activity.

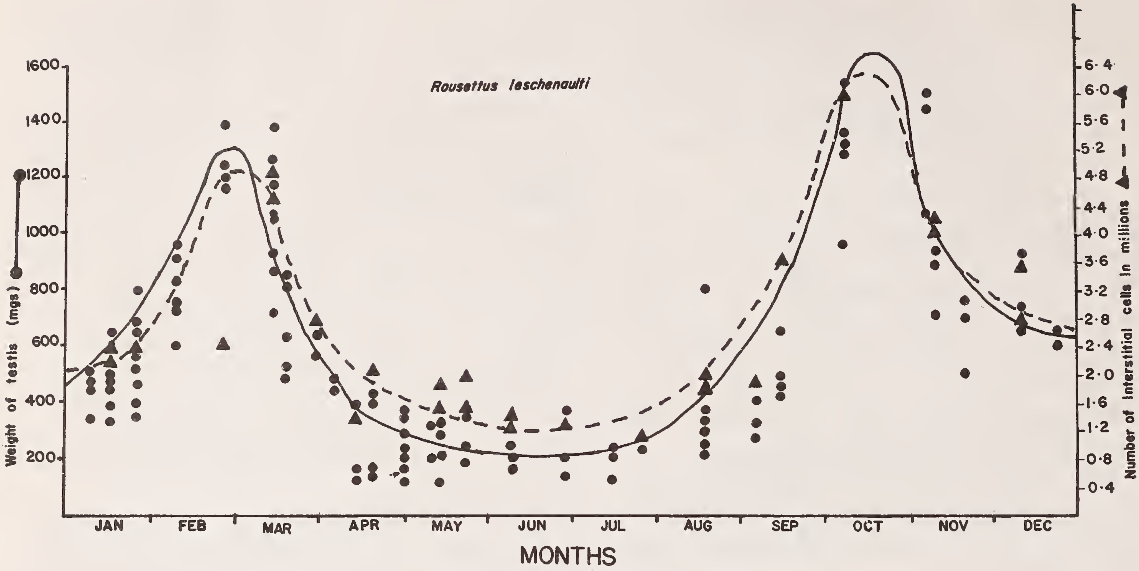


Fig. 2. Variations in weight of the adult testes and the number of interstitial cells during different months of the year in *Rousettus leschenaulti*. See text for descriptions.

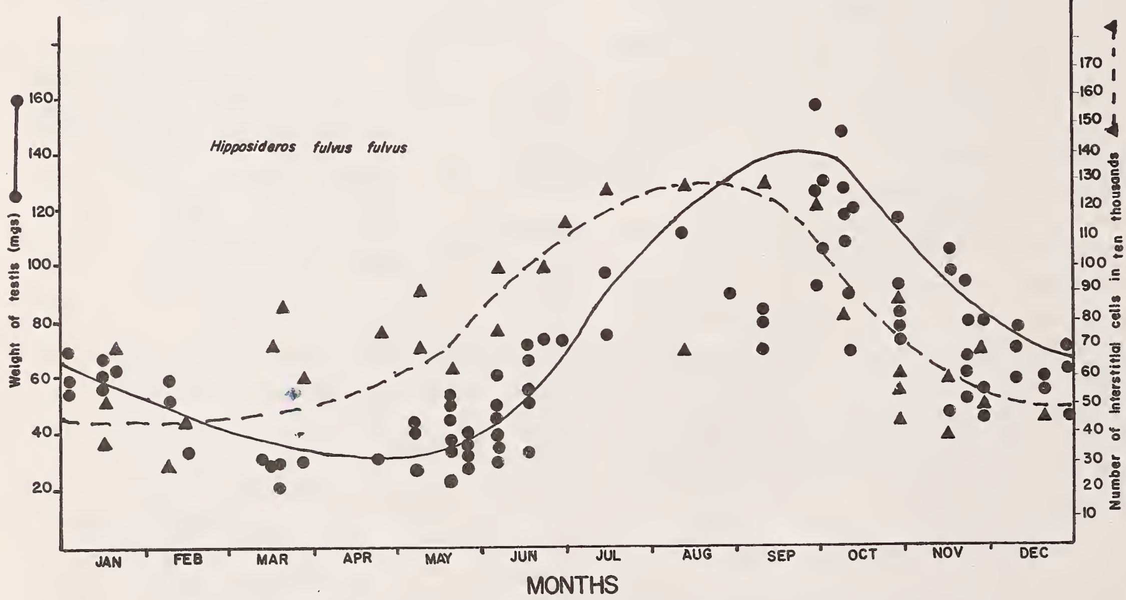


Fig. 3. Variations in weight of the adult testes and interstitial cells during different months of the year in *Hipposideros fulvus fulvus*. See text for descriptions.

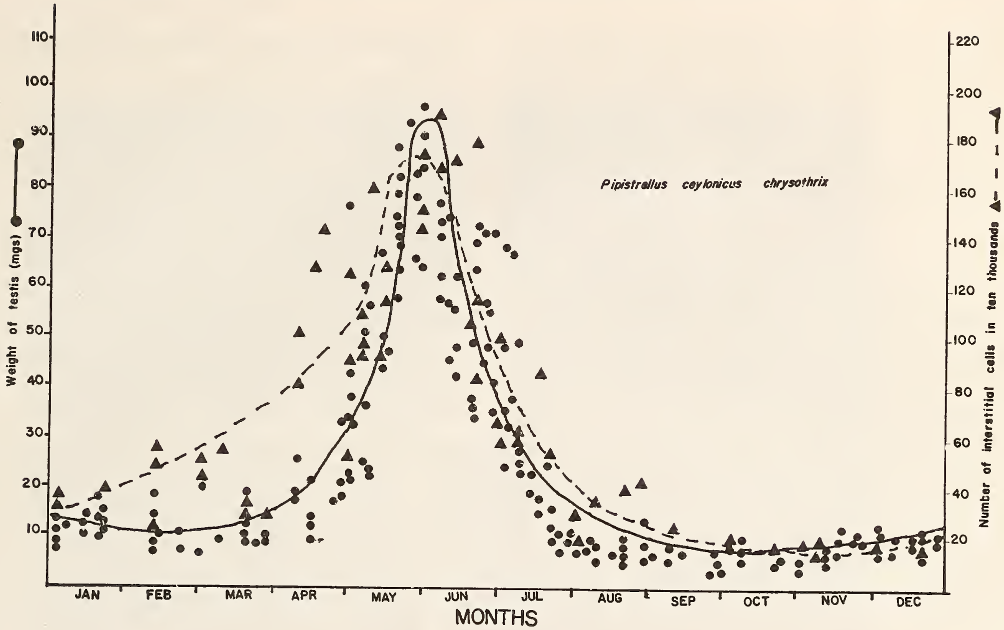


Fig. 4. Weight of adult testes and the number of interstitial cells during different months of the year in *Pipistrellus ceylonicus chrysothrix.* See text for descriptions.

The changes in the number of interstitial cells in the adult testis during the different months of the year are indicated in Fig. 3. The curve in the figure indicates that the interstitial cells are abundant during June to September, and become less numerous during the rest of the year. The period of highest abundance corresponds to the time just prior to commencement of spermatogenetic activity; the time when they start declining in number coincides with the period when the testis exhibits vigorous spermatogenetic activity. Evidently, regression of the interstitial cells in this species commences before the testis exhibits high spermatogenetic activity.

Pipistrellus ceylonicus chrysothrix

Copulation occurs during the first week of June, but ovulation does not occur until the second week of July (Madhavan 1971, Gopalakrishna and Madhavan 1979). During this period the inseminated spermatozoa are stored in the female genital tract (Gopalakrishna and Madhavan 1979). Each female delivers normally two, and rarely three young ones between the last week of August and the first half of September.

Males grow rapidly and attain sexual maturity when they are 8-9 months old. Hence, all males in the colony are sexually mature during the reproductive season.

Fig. 4 gives the testis weight of adult males during different months of the year. The testis weight commences to increase from April and attains the maximum during the second half of May, after which it progressively decreases and reaches low values from July to the end of the following March. Histological examination reveals that the testis is quiescent from July to the following March. Early spermatogenetic activity is noticed during April when the testis contains mostly spermatogonia and spermatocytes. Vigorous meiotic divisions and spermateleosis occur during May and continue (but less vigorously) during June. Hence, during this period the seminiferous tubules contain large

numbers of spermatozoa and the epididymides are full of spermatozoa. The accessory glands are in a high state of activity from the middle of May until the first week of July. This suggests that males are sexually active from May to the first half of July.

Discussion

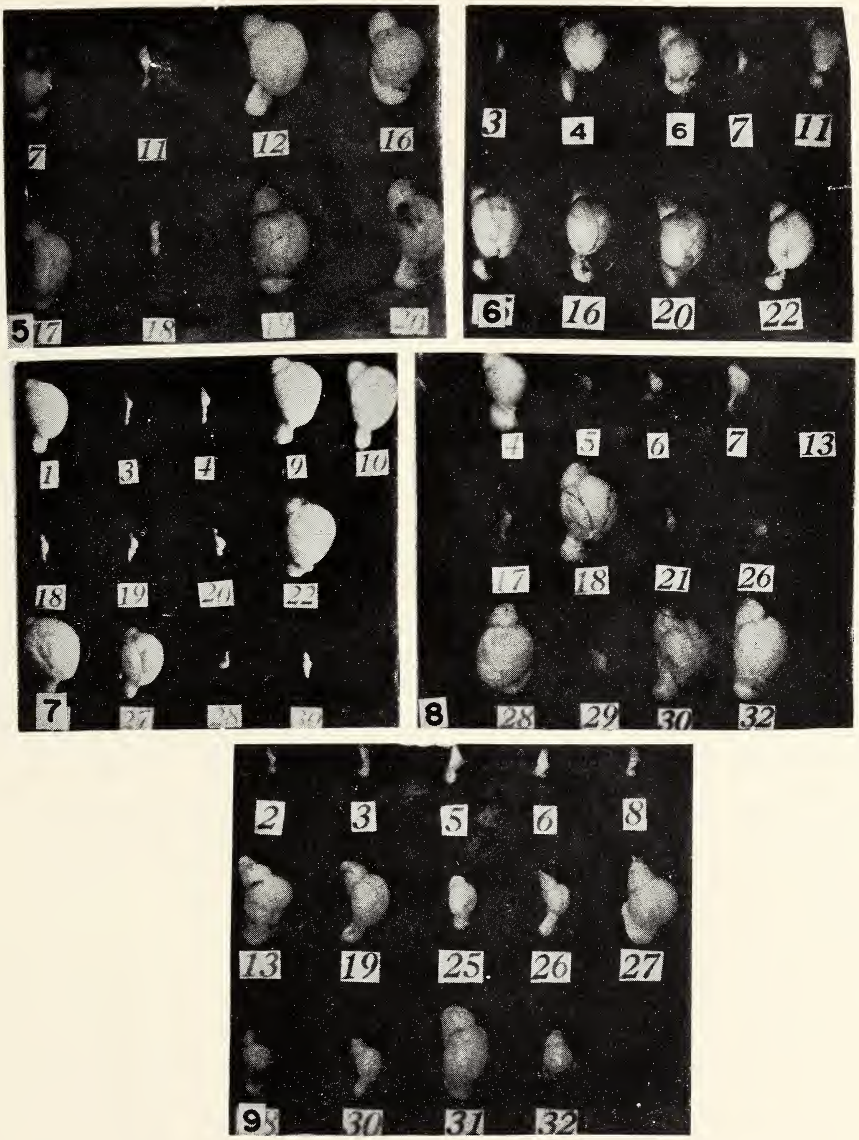
In *Rousettus leschenaulti,* where there are two strictly defined periods of heat in the females resulting in two litters in the year (Gopalakrishna and Choudhari 1977), the male seems to have a protracted period of elevated spermatogenetic activity and activity of accessory glands spanning both the cycles of the female. There is, however, a slight lowering of spermatogenetic activity in the testis and the secretory activity in the accessory glands during the period between the two periods of heat in the female, that is during December-February. It is, however, interesting to note that the regression in spermatogenetic activity in the testis and interstitial cells, and secretory activity in the accessory glands, does not fall to the level as in May when the animals are sexually quiescent. This suggests that elevated activity in the testis and accessory glands is maintained from October to the following April.

In *Hipposideros fulvus fulvus* there is only one sharply restricted breeding cycle in the year. However, while in the females oestrus is sudden and leads to copulation restricted to a strictly defined period in the latter half of November (Madhavan *et al.* 1979), spermatogenetic activity in the male extends for nearly three months — from September to November — and the epididymides are full of spermatozoa from September until December. The accessory glands are also most active from the third week of October to the middle of December. These facts suggest that while males are sexually competent from September through December, the period of copulation is determined by the female.

The situation in *Pipistrellus ceylonicus chrysothrix* is different from that in the other two species. Spermatogenetic and Leydig cell activity in the male commences in May and becomes most vigorous during the first half of June, after which it is considerably reduced until it ceases altogether by the second half of July. Accessory glands in the male are in the peak of activity during June and the first half of July. Thus, even after the abatement of spermatogenetic activity in the testis, the accessory glands remain active for a further period when the epididymides are full of spermatozoa. These facts suggest that the males retain their copulatory competence during June and the first half of July. This is probably an adaptation meant to serve those females which either missed copulation or were not successful during the early part of June, and to ensure that all females in the colony conceive. This is probably an adaptation to the far smaller number of males than females in the colony (Gopalakrishna and Madhavan 1970) and hence, each male needs to serve more than one female to ensure that all females conceive. In *P. c. chrysothrix* the spermatogenetic activity in the testis is not strictly synchronous with the activity of the accessory glands nor the activity in the female, unlike in the other two species in which there is a close synchrony of these activities. Females of this species have evidently developed a mechanism to store spermatozoa in the genital tract for several weeks prior to ovulation.

The fact that there are marked differences in the breeding rhythm of three species of bats inhabiting the same geographical region indicates that external factors such as temperature, rainfall and duration of daylight do not play a significant role in determining the breeding season of these bats.

H. f. fulvus and *P. c. chrysothrix* are approximately of the same size (8 to 10 g body weight) and roost in nearly identical kinds of places, and their food choice (small insects) is also the same. Yet their reproductive rhythms are different. Evidently, the reproductive peri-



Figs. 5 – 9. **Testes collected during different dates of the year. Note difference in sizes of testes during each collection.**
Fig. 5. Testes of specimens collected on 9 November 1965. Fig. 6. Testes of specimens collected on 16 January 1965.
Fig. 7. Testes of specimens collected on 9 February 1965. Fig. 8. Testes of specimens collected on 13 March 1965.
Fig. 9. Testes of specimens collected on 19 April 1965.
While during November to February the testes are of two distinct sizes, those collected in March and April are of three distinct sizes. See text for descriptions.

odicity is governed by factors within each species. The precise mechanism which controls the reproductive rhythm in such a rigid manner, is not known.

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NOTES ON THE ORANGERUMPED HONEYGUIDE *INDICATOR XANTHONOTUS* AND ITS ASSOCIATION WITH THE HIMALAYAN HONEY BEE *APIS LABORIOSA*[1]

Benjamin A. Underwood[2]

The orangerumped honeyguide *Indicator xanthonotus* and the Himalayan honey bee *Apis laboriosa* share geographic and altitudinal ranges. Confusion between the two large, open-nesting species of honey bees, *A. dorsata* and *A. laboriosa,* has obscured what is probably an exclusive association between *I. xanthonotus* and *A. laboriosa.* Environmental degradation and predation by honey hunters may explain the apparent scarcity of both *I. xanthonotus* and *A. laboriosa* in the western Himalaya. Observations of honeyguide behaviour in Nepal, coupled with published reports, suggest that *I. xanthonotus* males may establish territories at the time of natural migrations by *laboriosa* colonies and that such territories are held year-round. There is a need for additional data to define more clearly the association between *I. xanthonotus* and *A. laboriosa.*

Introduction

Until quite recently, the orangerumped honeyguide *Indicator xanthonotus* remained largely unknown. Specimens of the birds had been collected as early as 1842, but next to nothing was known of their biology or behaviour until the studies of Cronin and Sherman (1976) in Nepal and Hussain and Ali (1983) in Bhutan. A parallel situation exists with respect to the Himalayan honey bee *Apis laboriosa.* Although this largest of all honey bees was first described in 1871 (Moore *et al.*) from specimens collected in Yunnan Province, China, almost nothing was known of its natural history until the recent studies conducted by Underwood (1986, 1990a) in Nepal.

A recent study of *A. laboriosa* in western Nepal led to an opportunity to make some observations of the association between these bees and *I. xanthonotus.* Although the study focused on the bees and the data on *xanthonotus* take the form of casual observations, I hope that the thoughts presented here may contribute to our knowledge of these two fascinating creatures.

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Taxonomy

Honeyguides: Ornithologists are in general agreement that the orangerumped honeyguide is a single species, *Indicator xanthonotus,* described in 1842 by Blyth from a specimen collected in Darjeeling. Three subspecies have been described from the eastern (*radcliffi*), central (*xanthonotus*), and western (*fulvus*) parts of the honeyguide's range, but a paucity of specimens leaves the validities of these designations in some question (Ali and Ripley 1970).

With its distinctive markings, especially the flashing orange rump of a bird in flight, *I. xanthonotus* is unlikely to be confused with other Himalayan birds (see Ali and Ripley 1970, Fleming *et al.* 1976). Sightings coupled with behavioural observations of cerophagy (wax-eating) should dispel any lingering doubts as to the identification of the bird involved.

Honey bees: Until quite recently, most scientists regarded *Apis laboriosa* Smith as a high-altitude race of *A. dorsata,* also known as the giant honey bee or rock bee. A growing body of evidence suggests that the two are, in fact, separate species (Sakagami *et al.* 1980, McEvoy and Underwood 1988, Underwood 1990b) and that valuable biological information may be lost by confusing them.

From a distance, colonies of *A. dorsata* and

A. laboriosa look very similar. Both species build large (up to about 2 m across), single-comb nests in the open, enclosing the comb within a living blanket of bees several layers thick. On closer inspection, however, obvious differences between the two become apparent. The most striking differences involve colour patterns and size. Workers of *dorsata* are mostly brown, with black stripes on the dorsal surface of the abdomen, have black and brown thoracic hairs, and have an unengorged body mass of about 115 mg. Workers of *laboriosa* are entirely black (though they appear to have white stripes if the abdomen is distended), with long, tawny thoracic hairs and a mass of about 165 mg (Sakagami *et al.* 1980, Dyer and Seeley 1987, Underwood 1990a).

Differences in the size of workers are reflective of differences in cell size in combs of the two species. Combs of *A. dorsata* have cells that average less than 5.5 mm between parallel sides, while those of *laboriosa* usually average greater than 6 mm (Underwood 1986). Cell measurements can be useful in determining the bee species when no adults are available, but when an undeformed comb can be obtained (e.g., at abandoned nest sites).

Geographic Distributions and Ecological Notes

Honeyguides: Nearly all the reported sightings of *I. xanthonotus* have been from high-altitude locations in Bhutan, Burma, China, India and Nepal. Specimens have been collected from Hazara, Pakistan in the west (Hume 1870) to Burma in the east (Smythies 1949). Reports from the western Himalaya have been rare; most of our knowledge of *xanthonotus* is based on studies conducted in the central and eastern parts of the birds' range (Cronin and Sherman 1977, Hussain and Ali 1983).

Honeyguides are most often seen in close proximity to the abandoned combs of cliff-dwelling honey bees. Fleming *et al.* (1976) reported a honeyguide at 610 m in western Nepal, but other reports have been from altitudes of 1200 to 3500 m. Ripley (1950) suggested some altitudinal migration by *xanthonotus* and is supported by Hussain and Ali (1983).

Honey bees: The known range of *A. laboriosa* extends from western Nepal through Bhutan and the Assam Himalaya to Yunnan Province in China and includes part of Tibet (Sakagami *et al.* 1980). I am aware of anecdotal accounts of cliff-dwelling honey bees at high altitudes (>2000 m) in Kashmir. At least two published reports (Moorcroft and Trebeck 1841, Hussain 1978) seem to refer to *laboriosa* in Garhwal, but those accounts do not specifically identify the bees involved.

Morphological differences between *A. dorsata* and *A. laboriosa* workers probably reflect adaptations to the different environments in which colonies live; nest habitat may be an important clue in distinguishing between the two species in the field. *Apis dorsata* colonies seem to be confined to tropical and subtropical parts of Asia, while *laboriosa* nests in regions that experience a temperate to subalpine climate. In western Nepal, *laboriosa* colonies nest at altitudes of 1200 to 3500 m and migrate seasonally, avoiding the highest altitudes for all but a few months in summer (Underwood 1990a). *Apis dorsata* colonies are rarely, if ever, found above 1200 m in Nepal (pers. obs.). Reports of *dorsata* colonies at high altitudes (above the subtropical zone) in Nepal and elsewhere (e.g. Cronin and Sherman 1976, Hussain and Ali 1983) may be attributed to confusion between the two species of bees.

Study Area and Timing

Observations reported below were made between December 1987 and February 1989 in the valley of the Modi Khola river in west-central Nepal. The study involved nesting sites of *Apis laboriosa* on several cliffs at altitudes between 1250 and 3500 m (see Underwood 1990a). Observations of the association between *I. xanthonotus* and *A. laboriosa* were incidental

to the principal objectives of the study. One of those objectives was to determine the seasonal cycle of occupation by *laboriosa* colonies of several cliff sites within the Modi Khola valley. Towards that end, some observation periods were very brief: simple scans of a cliff to determine the presence or absence of bees. At other times, more extensive observations, some lasting most of a day, were carried out. Sightings of *I. xanthonotus* usually coincided with periods of extended observation of a given cliff site and failure to observe honeyguides at other times need not imply that they were not present. Place names given here are those of the cliffs themselves or of villages or other convenient reference points near the cliffs.

Observations

Landruk (1250 m): The cliff site at Landruk was observed for extended periods only during the time of a honey harvest in May 1988. 13 colonies of *A. laboriosa* had been observed on the cliff in April, but three had abandoned their combs prior to the harvest, which began on 17 May. On that date, a single *I. xanthonotus* was seen eating bee larvae or pupae that were probably diseased (see Underwood 1990a) and had been abandoned in one of the combs. Later that day, the honeyguide was observed eating the light-coloured wax at the top of the nest.

Kuli (1710 m): The Kuli cliff was occupied by *A. laboriosa* colonies from February to November 1988. At least one *I. xanthonotus* was seen at Kuli at various times from January to May 1988 and again from November 1988 to February 1989. The lack of sightings during summer 1988 was due to the fact that I was occupied elsewhere (at higher altitudes).

Dovan (2680 m): In December 1987, the cliff at Dovan was scaled and anchors were bolted to the rock so that an observation platform could be placed near *A. laboriosa* colonies the following summer. There were no colonies of bees at the sitè in December, but several abandoned combs remained from the previous summer. Placement of the anchors required six days and on each day, at least one *I. xanthonotus,* presumably the resident male, was seen nearby. On one occasion, a second bird appeared and was engaged briefly in an aerial chase by the first.

In 1988, colonies of *A. laboriosa* nested at Dovan from early June until early October. the cliff was observed extensively from July through October and at least one *I. xanthonatus* was present throughout that time. The bird had a favourite perch beneath a small overhang on the cliff and was often seen pecking at abandoned combs, but it never disturbed active *laboriosa* colonies and was never seen capturing bees. On 3 October, one of the last two *laboriosa* colonies remaining at Dovan abandoned its nest for the fall migration to lower altitudes (Underwood 1990a). The colony took off at 1023 hrs and within 30 seconds, the resident *I. xanthonotus* landed on the newly exposed comb and began to feed on that portion where the pollen was stored (near the top between the honey storage comb and the brood comb). The honeyguide was seemingly undisturbed by my presence, even though I was seated on the observation platform, less than 4 m away. Over the next hour, the bird made several trips between the comb and his perch. At 1125 hrs a second *I. xanthonotus* landed on the comb, prompting the first to leave his perch and chase the intruder away.

Bagar (3360 m): Bagar was occupied by *A. laboriosa* colonies from June to early October 1988, but was kept under extensive observation only for several days in late September. No *I. xanthonotus* was ever seen at Bagar and abandoned *laboriosa* combs there showed no damage that might be attributed to feeding by honeyguides. Indeed, the old combs at *Bagar* seemed to represent the accumulation of at least three years (exposed combs become progressively darker with age), to the extent that little nesting space remained.

Despite the fact that well over 100 hours

were spent bird-watching in the forests surrounding the various cliff sites, no *I. xanthonotus* was ever observed more than 100 m from a cliff on which old combs of *A. laboriosa* were present.

Discussion

Ripley (1950) suggested that *I. xanthonotus* might undertake altitudinal migrations, perhaps in the manner of the open-nesting honey bees on whose combs the honeyguides feed. Cronin and Sherman (1976), on the other hand, found that male *I. xanthonotus* defend their territories year-round and thereby gain access not only to a valuable resource (wax) but also to females that come to feed on that resource. In Bhutan, Hussain and Ali (1983) found the concentration of honeyguides around cliff bee sites to be especially heavy (20 or more at a single cliff) in October-November and suggested that there may indeed be some altitudinal migration on the part of the birds.

The observations reported here do little to clarify whether or not some honeyguides practice migration. Certainly the presence of *I. xanthonotus* at Dovan in both summer and winter suggests that particular territories are occupied year-round by resident males, but observations of the behaviour of satellite males were very limited. The number of honeyguides observed by Hussain and Ali (1983) in Bhutan was much greater than in the present study. Perhaps at high population densities, the behaviour of the birds may be somewhat different than at lower densities.

Hussain and Ali (1983) observed the greatest concentration of honeyguides at a 1900 m site in October-November and reported that at that time, there seemed to be the least amount of wax (abandoned combs) available. In Nepal, *A. laboriosa* colonies nesting on cliffs at altitudes below about 2000 m abandon their combs and move into the forest in late November (Underwood 1990a). If the behaviour of the bees in Bhutan is similar, a bonanza of combs would become available to *I. xanthonotus* at that time. Could it be that the honeyguides observed by Hussain and Ali were positioning themselves to take advantage of such a bonanza? Perhaps the ideal time to establish a territory is immediately after bees abandon a comb. That might explain the rapidity with which the resident male at Dovan 'staked his claim' after the migration of a *laboriosa* colony in early October. Several other abandoned combs had been available for some weeks; the bird's actions cannot be attributed to an urgent need for wax.

The coincidence between the altitudinal and geographic ranges of both *I. xanthonotus* and *A. laboriosa* may be an indication that the life history of the former is somehow tied to that of the latter and not to that of the other large, open-nesting honey bee, *A. dorsata*. Except for a single sighting at 610 m (Fleming *et al.* 1976; that bird may have been a stray?), all reports of *I. xanthonotus* fall within the 1200-3500 m nesting range of *A. laboriosa*.

The reported eastern limits of the ranges of both *I. xanthonotus* and *A. laboriosa* are nearly identical (Burma and Yunnan China), while reports from the western Himalayas are rare for both species. In contrast, the geographic range of *A. dorsata* extends far beyond the Himalayan region and includes nearly all of tropical and subtropical South and South-east Asia (Sakagami *et al.* 1980).

The close association between *I. xanthonotus* and *A. laboriosa* does not necessarily imply that the wax produced by *laboriosa* has any special characteristics (over that of wax produced by *A. dorsata*) essential to the honeyguides, though that is a possibility. If *I. xanthonotus* is a brood parasite, as are a number of the African honeyguides (Friedmann 1955), perhaps it is restricted to the habitat of its host species. That habitat may, for whatever reasons, coincide with the range of *laboriosa*.

In Nepal, and possibly elsewhere, environmental degradation and repeated honey harvests have apparently contributed to a decline in

populations of *A. laboriosa* (Valli and Summers 1988). Because of the close association between *A. laboriosa* and *I. xanthonotus* and the birds' apparent need for wax, a decline in the bee population may lead to a decline in the honeyguide population as well. That could explain the scarcity of both *A. laboriosa* and *I. xanthonotus* in the western Himalaya and the relative abundance of honeyguides in Bhutan, where harvests of cliff bee nests have been banned (Hussain and Ali 1983).

There is a need for additional data to clarify the relationship between *I. xanthonotus* and *A. laboriosa* and to determine if *xanthonotus* is ever associated with *A. dorsata*. Anyone interested in observing the orangerumped honeyguide would do well to seek out the nesting sites of the honey bees first. Certainly the chances of observing *I. xanthonotus* are much greater at those sites than elsewhere. Since both *dorsata* and *laboriosa* tend to nest at the same sites year after year and since honey from those nests is a precious commodity throughout much of the bees' range, people living near the nesting sites are usually well aware of their location. Local inquiries about bees can be a useful tool in the search for *I. xanthonotus,* even though many people may be unaware of the birds themselves. Efforts must be made to identify positively the species of bee involved and it is important that data, including altitude, about the location of any sightings be recorded. Clarification of the relationship between *I. xanthonotus* and *A. laboriosa* might facilitate efforts to protect the orangerumped honeyguide, as suggested by Hussain and Ali (1983).

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A KEY FOR THE IDENTIFICATION OF INDIAN GENERA OF FAMILY MEGACHILIDAE (HYMENOPTERA : APOIDEA)[1]

RAJIV K. GUPTA[2]

(With fifteen text-figures)

The Indian megachilid bees comprise about 150 species, grouped under 23 generic categories. A consolidated key for the identification of 34 genera of Megachilidae, including the Indian species is presented for the first time. Most of the characters enumerated in this key are illustrated with figures.

The family Megachilidae (subfamily Megachilinae Schenck, 1859, Jahrb. ver. Naturk. Nassau XIV: 19) was first differentiated to its present status by Schmiedeknecht (1886) and included the genera *Megachile, Lithurgus, Osmia, Heriades* and *Anthidium*. Earlier Smith (1853, 1854) had described numerous Indian species of the present day Megachilidae, housed at the British Museum. Recognition of subfamily status to Megachilinae was also forwarded by Dalla Torre (1894), under the family head of Apidae.

Since then, several new megachilid species have been described or recategorised under different genera. For example the majority of species formerly placed under *Apis, Andrena, Anthophora* etc. have been shifted to *Megachile, Heriades* and *Osmia* etc., during the early years of this century.

The first compilation of megachilid fauna of the Indian region was presented by Bingham (1897). His 'Apidae' included *Coelioxys, Heriades, Thaumatosoma, Anthidium, Megachile, Lithurgus, Osmia, Stelis* and *Parevaspis,* a total nine genera of present day Megachilidae. Among them *Stelis* and *Thaumatosoma* were described from beyond the present Indian territories. Later Michener (1965) reduced *Thaumatosoma* Smith (1865) to the rank of subgenus under the genus *Chalicodoma* Lepeletier.

Batra (1977) presented a key to the genera of Apoidea while describing the bio-ecology and management of some species of Indian bees. She added three more genera, *Chalicodoma, Anthocopa* and *Anthidiellum*, to the family Megachilidae (of Bingham 1897). The key presented was primarily concerned with the field identification of 35 bee genera, and included *Megachile* and *Chalicodoma* at the same rank. Some characters were also given for the identification of *Stelis* and *Parevaspis.*

Except these two papers, no further publication leading up to the level of genera of Indian Megachilidae is available.

The diagnostic characters of the family Megachilidae are: Fore wing with two submarginal or cuboital cells, both recurrent veins ending in or at base and apex of second cuboital cell (sometimes beyond as in *Anthidium*); pollen collecting scopa only in females and restricted from 2nd to 5th or 6th sternal plates (scopa absent in parasitic and Anthidinii genera); subantennal sutures directed towards the outer edges of antennal sockets (sutures are completely absent in Lithurginii); most of the female leaf-cutters with a clear bevelled cutting edge in the dentate margin of their mandibles, whereas resin users and cleptoparasites lack them; 3rd and 4th segments of labial palpi much smaller than 1st and 2nd and angulated from the basal two segments: larvae spin tough cocoons before pupation; apart from the cleptoparasites, many of the megachilids are highly restricted in their infrafloral relationship and thus oligolecty is a rela-

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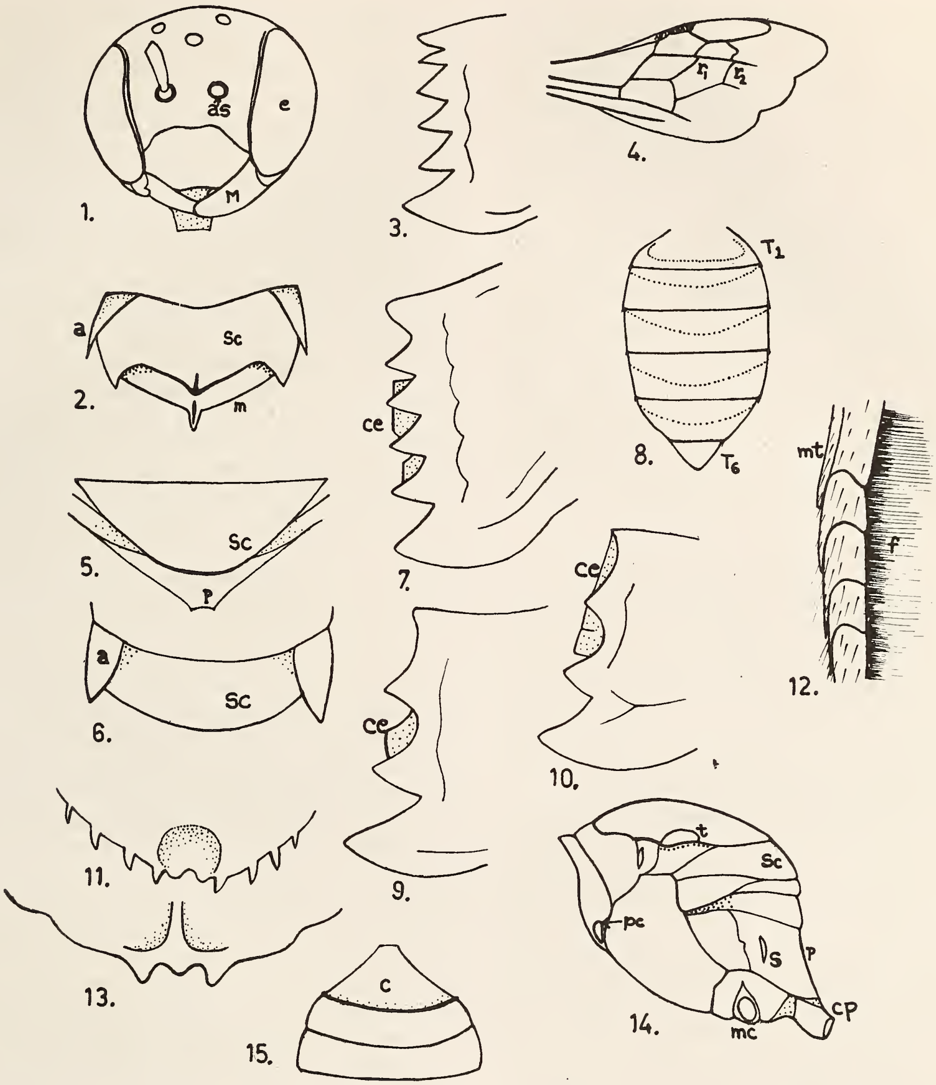

Figs. 1-15. Diagnostic characters for some genera of family Megachilidae.
1. *Lithurgus*: head, front view; 2. *Dioxys:* axillae, scutellum and metanotum (dorsal view); 3. Dentate margin in female mandible of *Anthidium*; 4. Forewing of *Paranthidium;* 5. *Parevaspis*: scutellum, metanotum and propodeum (dorsal view); 6. *Coelioxys*: axillae and scutellum (dorsal view); 7. Dentate margin of female mandible of *Creightonella*; 8. *Chalicodoma*: female metasoma in dorsal view; 9. Dentate margin of female mandible of *Eumegachile;* 10. Dentate margin of mandible of female *Megachile;* 11. Tergum 6th carnia in dorsal view of male *Megachile*; 12. Modification of front tarsi in male *Megachiloides*; 13. *Robertsonella*: produced apical truncation of clypeus; 14. Lateral view of generalised mesosoma (except wings and legs) in *osminii*, 15. *Heriades*: first tergal concavity margin carina in dorsal view.

Abbreviations: a-axilla; as-antennal socket; c-concavity; ce-cutting edge; cp-posterior coxa; mt-metatarsus; p-propodeum; pc-forecoxa; r_1 & r_2 - recurrent veins; s-spiracle; sc-scutellum; t-tegula; T_1 & T_6 - tergum first & sixth.

tively common phenomenon in this group.

Around 150 species of Megachilidae have so far been reported from India. They are grouped according to the most recent classification, within 23 genera. This paper deals with 34 genera, 12 of these have not yet been reported from India, but occur in the neighbouring countries, and are likely to occur in India. Furthermore, they reflect strikingly contrasting characters with those of paired Indian genera, and are therefore keyed along with Indian genera. *Aglaoapis* Cameron (1901, type-species: *A. brevipennis* Cam. 1901. Entomologist p. 262, from Bombay) and *Wainia* Tkalcu (1980, type-species: *W. lonavlae* Tkalcu 1980. *Annotnes. Zool. Bot. Bralislava 135:* 1-20) have not been listed in this key.

Key to the genera of Megachilidae

1. Pygidial area well developed in male, in female represented by a short spine; jugal lobe in posterior wing about 3/4th as long as vannal lobe; vestibule reaching up to mid-mesosomal segment; hind tibiae coarsely or finely spiculate dorsally .... *Lithurgus** Latreille

— Pygidial area absent in both sexes; jugal lobe of posterior wing less than half as long as vannal lobe; vestibule not so long; hind tibiae not spiculate 2

2. Body surface, especially metasomal terga, usually ornamented with pale integumental maculations; claws of female cleft or at least with an inner or subapical teeth; stigma short, its inner margin not much longer than its width 3

— Body surface other than legs never so maculated; claws of female simple or at most with basal angles or teeth; stigma elongate 13

3. Metanotum with a median spine; axillae produced to angles; second submarginal cell shorter than first; first transverse cuboital cell transverse to wing; scopa absent .... *Dioxys* Lepel. & Serville

— Metanotum simple; axillae rounded posteriorly; second submarginal cell usually as long as first; first transverse cuboital oblique; scopa present or absent 4

4. Scopa absent; mandible in male black, or if maculated, then clypeus black, at least in part 5

— Scopa usually present; mandible in male yellow, maculated, and clypeus entirely yellow 6

5. Margin of scutellum somewhat protuberant; propodeum completely vertical, without a dorsal pitted area .... *Heterostelis* Timberlake

— Margin of scutellum not at all protuberant; propodeum with a narrow but distinct dorsal pitted area .... *Stelis** Panzer

6. Arolia absent; mandible of female with 5 or more close set, conical teeth 7

— Arolia present; mandible of female with not more than four teeth 8

7. Seventh abdominal tergum of female with a large median emargination; second recurrent vein distad of second transverse cuboital by several vein widths .... *Callanthidium* Cockerell

— Seventh abdominal tergum of female without a median emargination: second recurrent vein not so much distad of second transverse cuboital .... *Anthidium** Fabricius

8. Hind margin of scutellum produced to form a carinate and broadly truncated tip, overhanging most of the propodeum; subantennal sutures more or less strongly arcuate outward, especially below .... *Anthidiellum** Cockerell

— Hind margin of scutellum not so produced and rounded; subantennal sutures straight 9

9. Posterior lobe of pronotum with its carina greatly expanded forward forming a lamella, extending along anterior border or mesoscutum; each posterior coxa toothed, largest in males ..... *Dianthidium* Cockerell

— Posterior lobe of pronotum not so broadly expanded, if carinate, anterior margin of carina restricted behind anterior margin of mesoscutum; posterior coxae not toothed; 8th abdominal tergum of male more or less modified with processes or a shallow emargination 10

10. Body not maculated, in ours complete metasoma brick red or black; a sharp carina separates the anterior and lateral faces of mesepisterna, scutellum produced back, overhanging full propodeum; scopa in female absent .... *Parevaspis** Ritsema

— Abdominal terga partly or fully maculated with yellow or ivory bands which may be entire or interrupted 11

11. Second recurrent vein received considerably beyond apex of 2nd submarginal cell; abdominal yellow bands submedian, interrupted medially, not strongly narrowed towards mid-line; ocelli extremely small, mandible of female terminating in long oblique margin .... *Paranthidium* Cockerell & Cockll

— Second recurrent vein received within or very near to apex of second submarginal cell; mandible of female tridentate, with not so strongly oblique apex 12

12. Abdominal terga with entire or nearly entire, transverse, apical or sub-apical, yellow or mostly

ivory bands; ocelli relatively large; maxillar palpi 3 – segmented .... *Heteranthidium* Cockerell

— Body entirely black, except for clypeus and paraocular areas of male; maxillary palpi 5-segmented .... *Trachusa* Panzer

13. Arolia absent; 6th tergum of male with a strongly elevated preapical ridge which is frequently toothed, notched or sometimes transformed into long transversely arranged spines; 7th tergum of male hidden or largely so 14

— Arolia present: 6th tergum of male without such a preapical ridge, the spines, teeth or notches, if present, usually at apical margin; 7th tergum more often exposed, but sometimes hidden 24

14. Axillae produced back to conspicuous spine; usually midscutellum with a carinate transverse ridge, separating anterior and distinctly angulate posterior surfaces of scutellum; apex of metasoma pointed or spatulate in female or with tergal spines, produced apically in male, scopa absent ..... *Coelioxys** Latreille

— Axillae not produced, often rounded posteriorly; scutellum convex or posteriorly rounded in profile; apex of metasoma in female not attenuate; and in male such prominently produced spines usually absent; scopa present 15

15. Mandibles of female with 5 or 6 almost equally spaced teeth, with incomplete cutting edges in 2nd to 4th interspaces; males with at least 5 or 6 exposed sternites .... *Creightonella** Cockerell

— Mandible of females with 3, 4 or 5 dents, cutting edges not as above, males with no more than 4 exposed metasomal sternites 16

16. Sternum 6 of female chiefly bare, at least apical half lacks scopal hairs, but with a straight row of short, subapical bristles and a bare apical lip; mid-tibial spur in males absent or greatly reduced .... *Pseudocentron** Mitchell

— Sternum 6 of female with a well clothed surface of scopal hairs or without a bare apical lip; mid-tibial spur in males well developed, in a few species suppressed or even absent, where basitarsi is much modified 17

17. Form usually narrow and elongate, metasoma parallel sided in males, terga strongly transversely convex in females; female mandible with, at the most, an incomplete cutting edge in 2nd interspace or lacking it also; in males sternum 4 is usually retracted, if exposed then mandible lacks any basal, ventral or submedian process 18

— Form broad, metasoma more cordate or ovoid in females; terga more flattened transversely; sternum 4 always exposed in males 19

18. Female mandible 4-dentate, with cutting edge in 2nd interspace, if cutting edge absent then clypeus much modified; in males tridentate with a distinct process, but if process absent then mandible much elongate and obscurely 4-dentate; sternum 8 finely setose at apical lobe in Indian species . . . *Eumegachile** Friese

— Female mandible lacks any cutting edge, either broad with 4 low vestigial teeth or with a sub-basal tooth, otherwise long and slender with 3 more or less distinct apical teeth; ventral process lacking in males; sternum 8 fringed at the margins of apical lobe .... *Chalicodoma* Lepeletier

19. Female mandible with 4 or 5 teeth, without cutting edges; inferior margin of male mandible usually with a process in Indian species; front coxae of males with distinct spines; form rather short with metasoma cordate .... *Chrysosarus** Mitchell

— Mandible of females 3, 4, or 5-dentate, with a cutting edge at least in the innermost interspace; front coxae may or may not bear spines; ventral process of male mandible may or may not be present 20

20. Mandible of female 4-dentate, inner angle blunt or truncate, 3rd tooth acute or obtuse, but 2nd interspace much wider and usually with a distinct cutting edge; male mandible without a distinct ventral process; front tarsi may or may not be modified .... *Cressoniella** Mitchell

— Mandible of female 3, 4 or 5-dentate, inner angle acute, second interspace often very narrow in those that are 4-dentate, with only a vestigial cutting edge; male mandible with a well developed ventral, basal process; front trasi often broadly dilated and brightly coloured 21

21. Males 22

— Females 23

22. Transverse carina of 6th tergum lacks a median emargination, in profile its upper surface is straight or slightly convex from base to apex of carina; margin of carina often crenulate or multispinose; apical margin of 6th tergum beneath carina, with a pair of acute lateral teeth and an inner pair of more carinate teeth .... *Megachiloides** Mitchell

— Transverse carina of 6th tergum flexed upward, surface forming an angle with the basal area of plate, usually with a definite median emargination but obscured by more lateral spines; lateral or inner teeth of apical margin, beneath carina very small or absent .... *Megachile** Latreille

23. Tergum 6th nearly or quite straight in profile; mandible 3-dentate, with only two well defined teeth near apex, 3rd tooth vestigial or absent, inner angle acute, a long cutting edge filling 2nd interspace; *or* apex of

sternum 6 thickened or produced above an apical fringe of short hairs; *or* mandible distinctly 4-dentate, 2nd interspace very small, inner angle acute .... *Megachiloides** Mitchell

— Tergum 6 concave in profile, towards apex; mandible 4 or 5-dentate; apex of sternum 6 not as above; if mandible 4-dentate, inner angle either truncate or blunt, or 2nd interspace more pronounced, usually with a short cutting edge .... *Megachile** Latreille

24. Thorax elongate, scutellum medially feebly convex in profile; metanotum convex and constitutes dorsal surface of thorax; propodeum with distinct horizontal base; shortest distance between tegulae usually but only slightly, greater than length of scutum; pterostigma broader than distance from inner edge of prestigma to costal margin of wing and longer than prestigma 25

— Thorax short, scutellum strongly convex in profile; metanotum flattened or convex, on posterior declivity of thorax; propodeum ordinarily entirely declivous; shortest distance between tegulae greater than length of scutum; pterostigma broader as above, but often as short as prestigma 30

25. Basal concavity of matasoma not at all carinate; second tergum with quite shallow concavity; posterior lobes of pronotum incarinate 26

— Basal concavity of metasoma with a carinate or subcarinate rim; second tergum with a deep or shallow concavity mid-basally; posterior lobes or margin of pronotum strongly carinate 35

26. First recurrent vein nearly or almost completely interstitial with first submarginal; shortest distance between tegulae is considerably greater than length of mesoscutum .... *Formicapis* Sladen

— First recurrent vein considerably far from the base of first submarginal; shortest distance between tegulae little, if any, greater than length of mesoscutum ... 27

27. Suture between mesepisternite and metepisternite straight in long median portion; scutellar surface oblique and medioposteriorly protuberant, metanotum slightly suppressed below the scutellar projection from dorsal view; clypeal truncation produced apically and overhead beyond the labral base in female; face below antennae in male covered with short, fine, appressed pubescence .... *Robertsonella** Titus

— Suture between mesepisternite and metepisternite arcuate; scutellar surface broadly but strongly convex; metanotum constitutes posterior declivity in continuation with scutellar margin; apical margin of female clypeus not so much produced, merely reaches up to labrum base; subantennal area of male with long pubescence 28

28. Six metasomal terga exposed in male; clypeus of female very short and broad, produced into a slender median apical horn ...... *Chelostomopsis* Cockerell

— Seven metasomal terga exposed in male; female clypeus not much modified 29

29. Posterior coxae each with a longitudinal carina on inner ventral angle; labial palpi with third segment flattened and connate with second, into one small cylindrical segment .... *Chelostoma** Latreille

— Posterior coxae incarinate; labial palpi with third segment cylindrical, similar to fourth .... *Prochelostoma* Robertson

30. Anterior and lateral faces of mesepisternite separated by a weak carina in between; second tergum with broad shining transverse concavity; seventh tergum of male quadridentate; brownish black, small bees .... *Ashmeadiella** Cockerell

— Mesepisternite carina absent, slight abrupt change in sculpture differentiate either faces; second tergum shallowly concave or merely sulcate 31

31. Parapsidial lines punctiform, or short oval, at most three times as long as broad; seventh tergum of male without tooth at either side on apical margin; always metallic forms 32

— Parapsidial lines linear; seventh tergum in male with teeth on apical margin, two on either side of median line; rarely metallic 33

32. Posterior coxae with longitudinal carina on inner ventral angle; parapsidial lines slightly elongate; propodeal carina arched slightly .... *Diceratosmia* Robertson

— Posterior coxae incarinate; parapsidial lines puncti form; propodeal carina straight...... *Osmia** Panzer

33. Body usually elongate; second tergum with basally flat or convex area, except median longitudinal sulcus, not separated from horizontal dorsal surface by a line or carina, except sometimes along the distance across the sulcus 34

— Body short and robust; basal area of second tergum broadly and shallowly concave, almost always separated from dorsal surface by transverse impressed line or feebly developed carina .... *Anthocopa** Lepeletier & Serville

34. Posterior coxae carinate at inner ventral angle; proboscis short, galeae and first two labial palpi segments furnished with numerous strong hairs, apices of which are hooked or wavy .... *Proteriades* Titus

— Posterior coxae not so carinate, rarely with an impunctate line replacing the carina; proboscis long, without unusual hairs .... *Hoplitis* Klug

35. Basal tergal concavity margin strongly carinate; second tergite with distinct transverse basal con-

cavity; axillae may or may not be produced posteriorly; scutellum sharply carinate midtransversely; apices of mid tibiae on its outer margin normal; body in general coarsely punctured ...... *Heriades** Spinola

— Basal tergal concavity margin mid-dorsally carinate; second tergum without baso-median concavity; axillae rounded posteriorly, minute; scutellum midtransversely broadly convex and angulated with the rest of posterior surface; apices of mid tibiae on its outer margin prominently produced, almost dentate; body in general not so coarsely punctured ... . *Eriades** Spinola

*Genera whose species are recorded from India.

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SURVEY OF THE GORAL *NEMORHAEDUS GORAL* (HARDWICKE) IN HIMACHAL PRADESH[1]

Paolo Cavallini[2]

(With three text-figures)

During October-November 1989, ten Wildlife Sanctuaries and a National Park in Himachal Pradesh, north-west India, were surveyed. Goral *Nemorhaedus goral* signs were recorded in eight of them. Two indices of relative abundance based on sightings and on droppings were used, and they correlated significantly ($p = 0.03$). Goral were seen active most often at sunrise and sunset. Group size ranged from 2 to 9, while 38% of the animals were seen alone. The lower altitudinal limit (*c.* 500 m a.s.l.) was substantially lower than previously believed for Himalayan goral. The main habitat requirement appeared to be the presence of steep (60° - 70°) slopes, probably as an antipredator strategy. Although widely distributed and locally abundant, goral seem to suffer from high disturbance and grazing levels.

Introduction

Gorals (*Nemorhaedus* spp.) are medium sized, mountain-dwelling ungulates, ranging from the Himalaya (*Nemorhaedus goral*) to the Burma-China-India border (*Nemorhaedus bailey*) and from Burma through China to the Soviet Far East (*Nemorhaedus caudatus*) (e.g. Groves and Grubb 1985). In spite of its wide distribution and relatively confident habits (Prater 1980), very little published information is available on this ungulate. Moreover, most of the information available is qualitative and second-hand (Mead 1989). The present study was undertaken as a first step towards gathering information on this species. Information collected on the status and distribution of goral in Himachal Pradesh and preliminary data on its habitat ecology are presented here.

Study Area

Himachal Pradesh (30° 12′ to 33° 12′ N, 75° 45′ to 79° 4′E) covers an area of 55673 sq. km. Terrain, and consequently vegetation, are very varied, from the plains covered by tropical jungle through a series of mountain ranges up to the main Himalaya, characterised by subtropical and temperate forests, to the highest peaks around 6000 m and the Tibetan plateau, that support only low scrub and grasses.

The survey period was from 6 October 1989 to 15 November 1989. Of the 29 wildlife sanctuaries and 2 National Parks in Himachal Pradesh (Mukerji 1986) 11 were excluded from the survey for the following reasons:

Four protected areas require special permits impossible to obtain in a short period (Pin Valley National Park, Lippa-Asrang, Racksham-Chitkul, Rupi-Bhaba). Four are present largely in the alpine zone, little used by goral (see e.g. Schaller 1977) (Kugti, Sachu-Tuan Nalla, Tundah, Kanawar). Three (Naina Devi, Govind Sagar, Pong Lake) are at very low altitude, with little or no suitable habitat for goral; in fact the latter two are lakes.

Of the remaining 20 areas the following 11 were selected as the most promising (based on the suggestions of B.S. Chauhan, A.C.C.F. Wildlife Circle, Himachal Pradesh) : Gamgul-Siya-Behi, Kalatop-Kajiar, Nargu, Great Himalayan National Park, Bandli, Shikari Devi, Majathal Harsang, Shimla Water Catchment Area, Chail, Renuka, Simbalbara (in north to south order; Fig.1).

Methods

For each area I recorded: (i) sightings, alarm calls and pellets of goral (pellets were not counted where goat and sheep grazing was

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intense), (ii) slope, aspect and cover (tree, shrub and bare rocks), (iii) intensity of grazing by domestic animals and other forms of disturbance.

Time spent in each of the protected areas is given in Table 1. Information on altitude and area were taken from the H.P. Forest Department. Statistical treatment follows Siegel (1956).

Results

Goral were sighted or heard in seven of the 11 areas surveyed. Pellets were recorded in eight of the 11 areas (Table 1). Distribution of sightings during the day is shown in Fig. 2. No goral was seen active between 0800 and 1630 hrs, while the maximum number was observed just after sunrise. This suggests a crepuscular (and possibly also nocturnal) activity. Moreover, most of the goral seen (61.4%) were moving and 11.4% were standing still, while only 4.5% were grazing or browsing. This further suggests nocturnal feeding activity, preceded and followed by crepuscular movements from and to the resting grounds.

The group sizes of the observed goral are shown in Fig. 3. The mode group size is one, but groups of two and four were also common; only one large group (nine goral) was observed. It must be noted, however, that these are minimum estimates because of the possibility of overlooking some of the members of a group. The distance (usually 100-300 m) and the brevity of the observations (often <1 min.) prevented an accurate assessment of age and sex.

No goral was seen on slopes less steep than 60° (N=61). Most of the sightings (86%) were in areas with fairly sparse tree and shrub cover (<30%). Also pellets were very common (up to 20 pellet groups per 30 min. walking) in areas with less than 30% cover but many (6.1 to 13.5 per 30 min. walking) were found also in forested areas (<60% cover). Bare rock (5 to 50%) was always present in areas frequented by goral. Aspect appeared rather unimportant, goral being present on north- as well as south-facing slopes. The areas surveyed are shown in Fig.1 and described in Table 1.

Gamgul suffers from heavy grazing and probably also heavy poaching. As a consequence, wildlife is generally very scarce. In spite of a habitat similar to areas with good goral densities, I saw no sign of goral during the survey; also the local Range Officer did not think that there was a significant population in the sanctuary.

Table 1
AREAS SURVEYED IN HIMACHAL PRADESH

Name	Area (sq. km)	Altitude m.a.s.l.	Goral Abundance		Grazing	Visibility	Time spent in	
			Sighting	Pellets			Goral area (hours)	Sanctuary (days)
Gamgul	90.0	2000-3900	0	0	4	4	8.30	1.5
Kalatop	47.3	1800-2500	0 +	6.1	1	0	4.55	2
Nargu	278.4	1200-4000	0	0	4	3	0	1.5
GHNP	620.0	1500-5000	0.23	—	2	3	4.40	2.5
Bandli	41.3	600-2100	0.23	2.3	0	3	17.35	2
Shikari Devi	213.5	2300-3360	0	0	3	1	0	2
Majathal	91.1	600-1970	5.42	20	0	4	6.25	3.5
Shimla W.C.A.	10.3	2100-2600	0 +	—	0	1	2.50	0.5
Chail	23.2	1000-2200	0.19+	—	3	4	11.30	3
Renuka	13.4	660-1100	0	3.8	1	0	3.00	1.5
Simbalbara	55.4	450-660	1.00	13.5	2	1	5.30	3

Areas are listed from north to south. Goral abundance indices: Sighting — no. of goral seen per 30 min. spent in goral areas (only during 0630-0800 and 1630-1800 hrs. Pellets= no. of goral pellets per 30 min. walking in goral areas. Grazing and visibility scores are on a 0-4 scale (0 = low, 4 = high). + goral alarm call heard.

Fig. 1. Areas in Himachal Pradesh surveyed for goral.

Kalatop is mostly covered by deodar *Cedrus deodara*. Slopes are mostly less than 60°. Disturbance is low (only two small villages are located within the sanctuary). Judging from tracks and scats, wildlife (especially pheasant and carnivores) appears comparatively abundant and goral is also present. The lack of sightings is related to the low visibility.

Nargu was the largest sanctuary visited. It was not possible to survey the whole area thoroughly. Goral presence appeared likely in some steep, grassy slopes, but due to the scarcity of such areas, and to heavy grazing pressure, this sanctuary is unlikely to support large goral populations.

Great Himalayan National Park: goral are most probably present not only in the three main valleys included in the park, but also outside, along the steep banks of the Sainji river. I surveyed only part of the northernmost valley

(Jiwa nal), where goral density is probably higher than suggested by the figures in Table 1. In fact, the area was disturbed during the days of survey by people collecting fuelwood for winter, which possibly made the goral shy. Grazing and other forms of disturbance are exceptionally rare in the core area of the park, but more important in the buffer zone.

Bandli possibly supports a high goral density. The low number of sightings (Table 1) is probably because of the tall grass which limited visibility, and also the presence of people cutting grass. Cover is very scarce (<15%) and slope very steep (>70°).

Shikari Devi is largely covered by deodar and slopes are mostly less than 50°. Disturbance (including grazing) is very high. Goral, if present, are certainly very scarce, and almost unknown to local people.

Majathal is by far the best area for goral among those visited. The goral is present in a habitat similar to that of Bandli, a chir pine *Pinus roxburghii* forest (actually a grassland with sparse trees). Two such areas, both very steep (60°-70°), are present in the sanctuary, together covering approximately 25 sq. km. Disturbance is very low and grazing almost absent. Only in this area were groups larger than two observed.

Shimla Water Catchment is an almost completely undisturbed area, not very steep (mostly <50°) and with a fairly dense tree cover (>80%). Goral, although present, did not appear to be abundant. It must, however, be stressed that the survey was too short for a definite assessment.

Chail suffers from very high anthropogenic pressures. People were seen throughout the goral area from early morning to late evening. It is possible (since the animal may be shyer than in other areas) that goral density is higher than suggested by Table 1. The high grazing pressure is, however, likely to limit wild herbivore populations.

Renuka: No goral was seen. However, many pellets were found, all close to a very steep (>70°) slope. The habitat (very thick tropical scrub) is unique among the sanctuaries surveyed. Goral density is probably high, even if limited to restricted patches.

Simbalbara: The habitat is low but with very steep (up to 90°) hills (660 m a.s.l.). Goral are present in the southern part of the sanctuary. The dense vegetation and the topography limited the visibility, possibly leading to an underestimation of goral density by the 'sighting' index (Table 1). The total population in this range may be good as the same habitat extends to the neighbouring state of Haryana. More work should be done on the ecology of goral in areas such as this and Renuka, as they represent the lower altitudinal limit of goral distribution.

The two abundance indices (Table 1) are significantly correlated (Spearman's $r_s = 0.762$, $p = 0.0275$; N=8) between areas, indicating that both can be used for a relative assessment of goral abundance. The 'sightings' abundance index is not significantly correlated to either the visibility ($r_s=0.484$, $p=0.129$; N=11) nor the time spent in goral areas ($r_s=0.413$, $p=0.27$; N=9; excluding sanctuaries with no time spent in goral areas; Table 1). This can be interpreted as an indication that none of these factors biased significantly the results of this survey.

Discussion

From the present survey, it appears that the goral in Himachal Pradesh is widely distributed (probably even outside protected areas) and in some areas it is still common. The three sanctuaries in which no goral sign was recorded (Gamgul, Nargu and Shikari Devi) are characterised by high grazing and possibly poaching pressure. More detailed research is clearly needed to assess the relative importance of these factors. Goral habitat, however, is fragmented, especially at the lower limits of its distribution. This might threaten in the long run the survival of some isolated populations, as happened in Thailand (Lovari 1986).

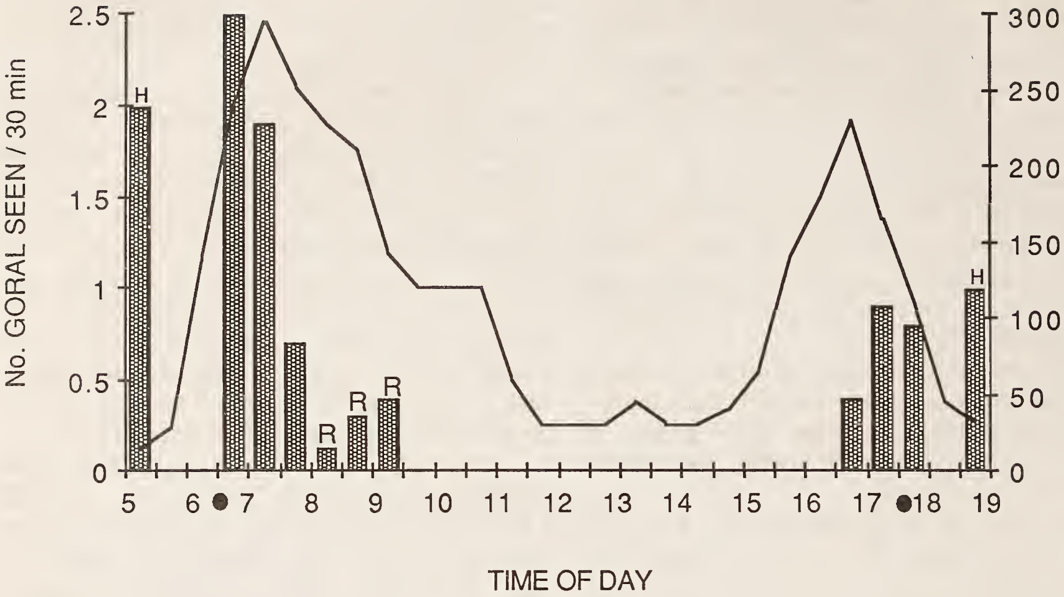

Fig. 2. Goral seen or heard per 30 min. observation (bars). Only time spent in areas in which goral were actually seen was included. R = resting animals, H = goral heard but not seen. Broken line indicates time spent in goral areas. Black dots indicate approximate sunrise and sunset times.

Gaston *et al.* (1981) found the goral altitudinal range to be between 1800 and 3700 m, with an abundance peak between 2200 and 3400 m. My results indicate a lower limit around 500 m (much lower than previously reported, see Mead 1989 for a review) with the highest densities in areas below 2000 m, which were little surveyed by Gaston *et al.* (1981). Also the preference for south-facing slopes observed by Gaston *et al.* (1981) could be a phenomenon limited to the upper part of goral range, as it could not be confirmed by the present study. On the other hand, my results agreed with those of Schaller (1977), Roberts (1977), Gaston *et al.* (1981), Lovari (1986) and Green (1987) in pointing out a preference of goral for very steep areas. The presence of leopard *Panthera pardus* in all the steep areas where goral was common (Kalatop, Great Himalayan National Park, Bandli, Majathal, Chail, Renuka, Simbalbara) suggests that this preference may be an antipredator strategy. My data therefore indicate that the main habitat requirement of goral is the

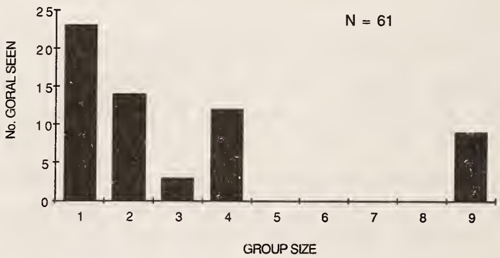

Fig. 3. Number of goral seen in groups of different sizes.

presence of steep slopes, together with low snow depth and low human disturbance.

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INSECT-HOST PLANT INTERACTION IN RELATION TO DEVELOPMENT OF *DIAPHANIA INDICA* (SAUNDERS) (LEPIDOPTERA: PYRALIDAE)[1]

CLEMENT PETER AND B.V. DAVID[2]

Various parameters were considered while studying the insect-host plant interaction between *Diaphania indica* (Lepidoptera: Pyralidae) and 18 cultivated cucurbits. Among the cucurbits screened for development of *D. indica*, muskmelon, longmelon, watermelon, pumpkin, squash and ivy gourd were the most preferred hosts while bitter gourd, bottle gourd, chow-chow, pointed gourd and sponge gourd were the least preferred hosts.

INTRODUCTION

The pumpkin caterpillar *Diaphania indica* (Saunders) has been reported from several parts of India and other regions of the world causing damage to various cucurbitaceous plants (Duport 1912, Vayssiere and Mimeur 1925, Esaki 1940, Hutson 1924, BA-Angood 1979). In India Patel and Kulkarny (1956) conducted detailed studies on the biology of this insect pest. Pandey (1975) screened seven cultivated cucurbits at Bharwari for their relative preference to *D. indica.* Krishnaprasad and Rai (1978) screened five cucurbits at Dharwar. However, not much work has been carried out with this insect pest in Tamil Nadu and much less on the insect-host plant interaction. In the present investigation 18 cultivated cucurbits were screened for their relative preference to *D. indica* for development.

MATERIAL AND METHODS

The 18 cultivated cucurbits selected for this study were: (i) musk melon *Cucumis melo* L., *(ii)* long melon *Cucumis melo* var. *utilissimus* Duth. and Full., (iii) round melon *Praecitrullus vulgaris* L., (iv) ridge gourd *Luffa acutangula* L., (v) sponge gourd *Luffa cylindrica* L., (vi) pointed gourd *Trichosanthes dioica* Roxb., (vii) spiny gourd *Momordica cochinchinensis* Spreng., (viii) chow-chow *Sechium edule* (Jacq.), (ix) watermelon *Citrullus lanatus* (Thunb.), (x) bottle gourd *Lagenaria siceraria* (Mol.), (xi) bitter gourd *Momordica charantia* L., (xii) pumpkin *Cucurbita moschata* (Duch.), (xiii) ash gourd *Benincara hispida* (Thunb.), (xiv) snake gourd *Trichosanthes anguina* L., (xv) squash *Cucurbita pepo* L., (xvi) ivy gourd *Coccinia indica* Wight and Arn., (xvii) cucumber *Cucumis sativus* L., (xviii) small gourd *Cucumis melo* var. *agrestis* Naud.

15 of these cucurbits were raised in separate rows of 12 m length. For the remaining three varieties, viz. ivy gourd, snake gourd and small gourd, leaf samples were taken from established fields. For assessing the varietal preference, the following parameters, viz. larval development, larval period, larval weight, pupal period, percentage of pupation, percentage emergence of pupae, growth index, fecundity and field infestation were recorded. The Growth Index was estimated following the method adopted by Srivastava (1959).

The studies were carried out with 10 freshly hatched larvae and three replications were maintained for each variety. The total larval period on each of these varieties as well as larval weight at the end of 10 days were recorded. Fecundity of the moths reared on these hosts was determined by enclosing the mated female moth in the rearing jar on leaves. Three female moths were enclosed separately for each host plant.

RESULTS AND DISCUSSION

Various parameters were considered for

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TABLE 1
INSECT-HOST PLANT INTERACTION IN RELATION TO DEVELOPMENT OF *D. indica*

Host Plant	Larval period (days)	Larval weight (mg)	Pupal period (days)	% Pupation	% Emergence of adults	Growth index	Fecundity	No. of larvae on plant in field
1. Musk melon	9.40^{a}	50.54^{abc}	6.80^{a}	72.66^{ab}	80.84^{ab}	5.85	198.00^{a}	3.98
2. Long melon	10.60^{a}	32.33^{oef}	8.20^{cde}	71.33^{ab}	73.90^{abcd}	5.24	157.80^{cde}	3.52
3. Round melon	15.33^{f}	25.04^{f}	9.10^{def}	58.66^{cd}	61.41^{def}	3.20	79.00^{ef}	1.18
4. Ridge gourd	11.13^{bc}	27.53^{f}	7.80^{abc}	40.00^{ef}	53.53^{ef}	2.79	129.60^{de}	1.16
5. Sponge gourd	13.13^{e}	32.03^{def}	10.30^{g}	29.33^{f}	43.01^{fg}	1.81	28.40^{f}	0
6. Pointed gourd	13.86^{e}	24.48^{f}	7.00^{ab}	31.33^{f}	46.21^{f}	1.85	42.30^{ef}	0
7. Spiny gourd								0
8. Chow-chow	15.26^{f}	47.54^{abcde}	9.30^{ef}	35.33^{f}	42.47^{fg}	1.93	68.70^{e}	0.70
9. Water melon	10.53^{b}	60.62^{a}	7.30^{abc}	76.66^{a}	84.43^{a}	5.66	164.70^{ab}	3.24
10. Bottle gourd	13.40^{e}	37.63^{bcdef}	10.20^{fg}	28.60^{f}	30.55^{g}	1.74	78.40^{ef}	1.17
11. Bitter gourd	15.67^{f}	23.18^{f}	10.20^{fg}	37.33^{ef}	31.26^{g}	1.99	90.60^{ef}	—
12. Pumpkin	11.33^{bc}	50.14^{abc}	7.70^{abc}	74.00^{ab}	74.69^{bcd}	5.16	133.80^{abc}	3.15
13. Ash gourd	12.86^{de}	40.18^{abcdef}	9.70^{fg}	55.33^{cd}	70.95^{abc}	3.48	176.00^{ab}	2.12
14. Snake gourd	12.06^{cd}	34.70^{cdef}	8.10^{bcd}	54.00^{cd}	64.32^{cde}	3.58	100.20^{bcd}	—
15. Squash	11.00^{b}	50.32^{abc}	6.60^{a}	77.33^{a}	82.14^{ab}	5.52	146.40^{ab}	3.23
16. Ivy gourd	10.13^{bc}	53.26^{ab}	7.70^{abc}	76.00^{a}	77.01^{abc}	5.37	152.40^{ab}	—
17. Cucumber	12.07^{cd}	45.14^{abcdef}	9.70^{fg}	64.00^{bc}	68.25^{cd}	4.24	119.80^{abc}	2.14
18. Small gourd	11.47^{bc}	48.17^{abcd}	9.40^{fg}	47.33^{de}	65.82^{cde}	3.27	104.00^{bcd}	2.19

Figures followed by the same letters are not significantly different from each other by DMRT (P=0.05).

evaluating the host plant preference of *D. indica.* The results are shown in Table 1.

Rate of larval devlopment: Among the 18 cucurbits screened for larval development, the shortest larval period of 9.40 days was recorded on musk melon (Table 1; column 1); it was significantly shorter than the duration required for development on the other hosts. This was followed by long melon, water melon and squash which were on par with each other. The larval periods on sponge gourd (13.13 days), bottle gourd (13.40 days) and pointed gourd (13.86 days) were significantly longer than on other host plants. There was no larval development on spiny gourd.

Larval weight: The weight of larvae reared on the various cucurbits were recorded on the 10th day after hatching; data are shown in Table 1 (column 2). The maximum weight (60.62 mg) was recorded for larvae fed on water melon followed by ivy gourd. The weights of larvae reared on musk melon, squash, small gourd and cucumber did not differ significantly from each other. The larval weight was low when reared on pointed gourd, round melon and ridge gourd.

Duration of pupal period: The duration of pupal period for larvae reared on the various cucurbits is shown in column 3 of Table 1. The shortest mean pupal period of 6.60 days was recorded with squash followed by musk melon. When reared on ivy gourd, pumpkin and ridge gourd it was longer by a day; these were on par with each other. The pupal period was longer still when reared on small gourd, ash gourd, sponge gourd, bottle gourd and bitter gourd.

Success of pupation: The number of larvae that developed and pupated successfully on the various host plants were recorded and the extent of pupation calculated from this data. The maximum percentage pupation was obtained with squash (77.33%), followed by ivy gourd, pumpkin, musk melon and long melon. These did not differ significantly and were higher compared to the other host plants. The pupation rate was low with bottle gourd, sponge gourd,

pointed gourd, chow-chow and bitter gourd.

Emergence of adults: The percentage emergence of pupae when reared on the various cucurbits was recorded (column 5 of Table 1). Maximum emergence of pupae was recorded for water melon (84.43%) followed by squash and musk melon. Lower emergence were recorded for bottle gourd, bitter gourd, chow-chow, sponge gourd and pointed gourd.

Growth index: To assess the overall capacity of various cucurbits to support growth and development, growth indices were calculated (column 6 of Table 1). The results indicated that musk melon, water melon, squash, ivy gourd, long melon, and pumpkin are better hosts than the other cucurbits. The growth indices of cucumber, snake gourd, small gourd and ash gourd were lower. The growth indices for cucurbits, viz. sponge gourd, chow-chow, Pointed gourd and bottle gourd were very low, indicating that these plants are probably not preferred hosts but in the absence of the preferred hosts *D. indica* can survive on these cucurbits.

Fecundity: The fecundity of females reared from the various plants was determined (column 7 of Table 1).

The study indicated that the maximum number of eggs were laid by moths reared on musk melon (198.0), followed by, ash gourd, water melon long melon and ivy gourd. The lowest number of eggs were from moths reared on sponge gourd, chow chow, bottle gourd, round melon, pointed gourd and bitter gourd.

Effect of host plants on field infestation: 15 cucurbits raised in the field were sampled for natural infestation of *D. indica*. The plants raised in pandals (Bower system), viz. snake gourd, ivy gourd and bitter gourd were not included in the sampling since the sample units between these two types of cultivation were not uniform.

The mean number of full grown larvae per plant are shown in the last column of Table 1. High larval population occurred on musk melon (3.98), followed by long melon, water melon, squash and pumpkin. Sponge gourd, pointed gourd and spiny gourd did not harbour any larvae at all which indicated that these are not attacked when more preferred hosts were present.

Based on the above observations on host preference of *D. indica* it is possible to classify the 18 cucurbits into three broad categories.

(a) *Most preferred hosts*: Musk melon, long melon, water melon, pumpkin, squash and ivy gourd.

(b) *Moderately preferred hosts:* Cucumber, small gourd, snake gourd, ash gourd, round melon and ridge gourd.

(c) *Least preferred hosts*: Bitter gourd, bottle gourd, chow-chow, pointed gourd and sponge gourd.

Ayyar (1923) and Fletcher (1914) reported the occurrence of *D. indica* as a pest of cucurbitaceous plants. Pandey (1975) refuted this observation on the grounds that in his investigations at Bharwari, where seven cucurbits were screened, *D. indica* did not develop on bitter gourd. The development on the other hosts, viz. musk melon, round melon, pumpkin, watermelon, sponge gourd and ridge gourd was quite normal, and among these plants the percentage of larval pupation was highest on musk melon and lowest on ridge gourd. In the present study *D. indica* completed its development on bitter gourd, while sponge gourd was the least preferred host. *D. indica* failed to develop on spiny gourd.

Krishnaprasad and Rai (1978) screened five cucurbits, bitter gourd, bottle gourd, pumpkin, ridge gourd and snake gourd. Ridge gourd was the most preferred host plant followed by snake gourd, pumpkin and bottle gourd. The variation reported in the most preferred host by Pandey (1975) and Krishnaprasad and Rai (1978) is interesting. The former recorded musk melon as the most preferred and ridge gourd as the least preferred, while the latter reported ridge gourd as the most favoured host. In the present study *D. indica* developed on bitter gourd contrary to the report

of Pandey (1975). Similarly, bottle gourd was reported as a favourable host by Krishnaprasad and Rai (1978), while in the present investigation it has been classified under the least preferred. The development reported by these authors on the other cucurbits, viz. ridge gourd, pumpkin and snake gourd are more or less in conformity with the present study.

Considering the extent of variation in the insect host plant interaction of *D. indica* reported in literature, it may be concluded that probably all cucurbits are potential hosts of this insect. The earlier reports by Fletcher (1914) and Ayyar (1923) that most cultivated cucurbits are susceptible to *D indica* appears to be authentic in the light of the present findings. The rather contradictory results obtained in relation to development may be due to the varieties and regions selected for this experiment. However, since the varietal names of many of the cultivated cucurbits are not given it is difficult to determine whether or not a particular cucurbit is a potential host. We can only assume that all cucurbits are potential hosts of *D. indica* but some cucurbits (like musk melon, long melon, water melon, ivy gourd etc.) are better than others (bottle gourd, bitter gourd etc.).

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SYMPATRIC DISTRIBUTION OF GHARIAL *GAVIALIS GANGETICUS* AND MUGGER *CROCODYLUS PALUSTRIS* IN INDIA[1]

R.J. RAO[2] AND B.C. CHOUDHURY[3]

(With a text-figure)

This paper briefly deals with present status of wild gharial *Gavialis gangeticus* and mugger *Crocodylus palustris* in their major habitats. In the Chambal river the basking sites of mugger (77.7%) were rock and for gharial (22.2%) sand banks, though their nesting sites were the same. The distribution of gharial in this river was restricted to 68 (83.9%) survey units of 5 km each whereas mugger were restricted to 18 (22.2%) units. From this study it appears that to minimise the level of interspecific competition more conservation management inputs should be given to gharial in the Ganges and Brahmaputra river systems whereas more management inputs are necessary for the mugger in southern India and in the rest of its allopatric range.

INTRODUCTION

The results of a status survey in India conducted during the mid 1970s showed that the mugger *Crocodylus palustris,* once widespread and common, had become rare throughout its range by the early 1970s (Whitaker and Daniel 1980). The mugger is now present in small numbers in almost all the states of India except Jammu & Kashmir, Himachal Pradesh and Punjab (Whitaker and Whitaker 1989). The gharial *Gavialis gangeticus* once inhabited the major Himalayan fed river systems but is now restricted to the Ganges and Brahmaputra river systems. It is also found in the Mahanadi (FAO 1974) and was perhaps once found in the Godavari river (Bustard and Choudhary 1982) in Peninsular India.

SYMPATRIC DISTRIBUTION

The gharial and mugger are sympatric in some north Indian rivers, and in the Mahanadi river in eastern Orissa. The range of the mugger overlaps with that of the gharial in Rajasthan, Madhya Pradesh, Uttar Pradesh, Bihar and Orissa. However, the mugger also occurs in the same locality in habitats other than rivers. The major Indian rivers which both gharial and mugger inhabit are: Chambal, Son, Ken, Yamuna, Ramganga, Ghaghra, Girwa, Kosi and Mahanadi (Fig.1).

Present status: Data from published literature, field surveys and interviews with local people indicate that fairly good populations of mugger are present in different states, particularly in protected areas. But the gharial is found only in protected areas.

The Chambal river is one of the major gharial habitats in the country and monitoring of the gharial population is being carried out regularly. Since 1975 the gharial population in the Chambal has increased considerably. Around 800 gharials of all size classes and 50 nests were recorded from Chambal during 1988, whereas only 38 mugger have been reported from the same area.

In the Son river, 66 captive reared gharial have been released between 1985-90 and a natural population was also reported here. A total of four mugger were present in the Son river including two released mugger.

Whitaker and Daniel (1980) have reported eight mugger and four gharial from the Ramganga River inside the Corbett National Park in Uttar Pradesh. During 1982-1984 a total of 27 captive reared gharial and 12 mugger were released in the Ramganga river (Basu, pers. comm.).

A breeding population of gharial is present

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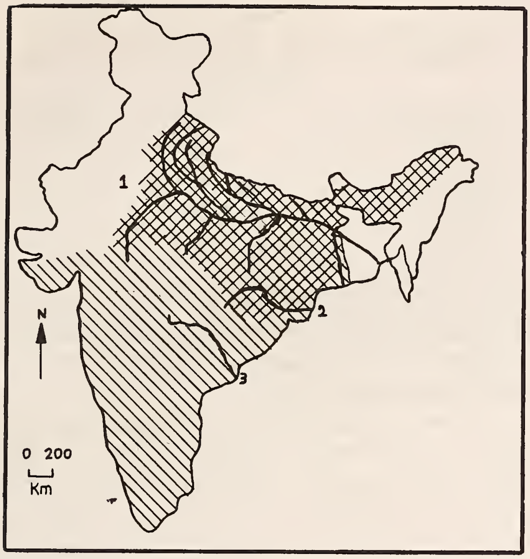

Fig. 1. Sympatric distribution of gharial and mugger in India. Striped area represents allopatric range of mugger, square area represents sympatric range of gharial and mugger. 1. Ganges river system, 2. Mahanadi river, 3. Godavari river.

in the Katerniaghat Sanctuary on the Girwa river with approximately 20 animals (Whitaker and Daniel 1980). Mugger are also reported from this river. During 1979-1986, 129 captive reared gharial were released in the Girwa river.

In the Mahanadi river 550 captive gharial have been released so far (Kar 1989). Mugger have also been reported from this river (FAO 1974) (Table 1).

Habitat Requirements

Since 1974, detailed studies on the habitat preference of mugger and gharial have been undertaken (Choudhury 1981, Choudhury and Bustard 1982, Singh 1978, 1985). However, information on many aspects of habitat selection and utilisation pattern by sympatric crocodile species is scanty.

In a survey conducted on the Chambal river during 1988, mugger were sighted in 18 survey units (22.2%) and gharial in 68 units (83.9%). Each unit represented a 5 km river stretch of the Chambal river. Young mugger were very few in number (22.2%) indicating that the population recruitment of mugger in Chambal is low.

Ecological studies on the Chambal river revealed that the basking habits of the two species differ significantly. The mugger mainly prefer to bask on rocks (77.7%) and rarely on sand (22.2%). The gharial bask on sand banks or on sand bars (98%), and only occasionally on rocks (2%) (Rao and Sigh 1987).

In the Chambal river both gharial and mugger breed successfully. The nesting season for both species was March-April. During 1988, a total of 15 gharial nesting sites were identified where 50 gharial nests were located (Rao 1988). Mugger used four nesting sites along with gharial (Table 2). A total of 15 mugger nests were located during 1988 at these sites. No conflict for the selection of nesting sites was observed between gharial and mugger. At one

Table 1
MUGGER AND GHARIAL RELEASE IN INDIA

River	State	Year	Gharial	Year	Mugger
Chambal	Madhya Pradesh/Uttar Pradesh	1979-90	1532	1984	28
Son	Madhya Pradesh	1985-89	66	1983	2
Son	Uttar Pradesh	1990	30	—	—
Rapti	Uttar Pradesh	1986	10	1984	10
Girwa	Uttar Pradesh	1979-86	129	—	—
Ghagra	Uttar Pradesh	1986	20	1985	6
Ramganga	Uttar Pradesh	1982-84	27	1984	12
Sharda	Uttar Pradesh	1986	20	—	—
Ken	Madhya Pradesh	1985-87	20	—	—
Mahanadi	Orissa	1977-89	550	—	—

TABLE 2
NESTING SITES OF GHARIAL AND MUGGER IN THE CHAMBAL RIVER DURING 1988

Sl. no.	Nesting site	Species
1.	Bagdia sandh	gharial
2.	Gobarda	gharial + mugger
3.	Baroli	gharial + mugger
4.	Nadigaon	gharial + mugger
5.	Banwara	gharial
6.	Bharra	gharial + mugger
7.	Dang Basai	gharial
8.	Tigri Rithoura	gharial
9.	Papripura	gharial
10.	Pureni	gharial
11.	Daljitpura	gharial
12.	Barsala	gharial
13.	Barenda	gharial
14.	Khera	gharial
15.	Gyanpura	gharial

nesting site near Nadigaon 5 mugger shared the nesting ground with 10 gharial in a 200 sq. m area (Table 3). This indicates that interspecific use of nesting grounds is very high. The survey results show that 26% of the mugger nesting sites overlapped with gharial nesting sites.

Discussion

With a diverse habitat and dietary preference (unlike the gharial which is exclusively a fish eater and seems to select deep, fast flowing rivers), the more adaptable mugger tends to fail in competition with the gharial where sympatric. In its allopatric range (i.e. south and west India) the mugger is quite successful. The reason for this is not clear. Lack of information on resource utilisation by gharial and mugger in their sympatric range makes it difficult to understand the reasons for niche separation between these species.

Unlike the gharial which is thriving in its range, the low density and low recruitment rate of mugger in the northern Indian rivers suggests that they are not adaptable to deep and fast flowing Himalayan fed rivers.

TABLE 3
NUMBER OF GHARIAL AND MUGGER NESTS AT COMMON NESTING SITES ON THE CHAMBAL RIVER DURING 1988

Nesting site	Gharial	Mugger
Gobarda	3	1
Baroli	9	3
Nadigaon	10	5
Bharra	4	1

However, the fundamental question is, how does the selectively adapted gharial compete with more adaptable mugger? Perhaps gharial are more adaptable to swimming in deep and fast flowing rivers. Our preliminary observations in the Chambal river indicate that the natural recruitment of gharial was greater than mugger, even though hatching of both gharial and mugger took place at the same nesting sites. Occurrence of fewer mugger hatchlings at the same nesting sites makes us wonder if gharial prey on mugger hatchlings.

To minimise the level of interspecific competition between sympatrically distributed endangered crocodiles in India, more conservation management inputs should be given to gharial in the Ganges and Brahamaputra river systems. At the same time more inputs should be given to mugger in southern India and in the rest of its allopatric range.

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WINTERING WATER BIRDS AT POINT CALIMERE, TAMIL NADU [1]

V. NATARAJAN [2]

(With a text-figure)

Details of bird ringing and census studies of waterbirds carried out during the year 1985-86 at Pt. Calimere Wildlife and Bird Sanctuary, Tamil Nadu, are given. A total of 5321 birds of 38 species were ringed, predominantly little stint *Calidris minuta*, ruff and reeve *Philomachus pugnax* and curlew sandpiper *Calidris ferruginea*. 104 birds of five species were recaptured. Among these, the little stint was the maximum. Two birds (little stint and ruff) with Russian rings were recovered. The physical measurements of eight species of waders were analysed. The wing-tarsus ratio for lesser sand plover *Charadrius mongolus* reveals that the majority of the population visiting Pt. Calimere are of the *atrifrons* group. The seasonality, diversity and density of waterbirds are discussed. The bird population fluctuates in different months in relation to water level and food availability. The mean monthly bird species diversity recorded was 2.01 and the annual mean bird density (all species) was 516 birds/sq. km.

INTRODUCTION

Pt. Calimere (10°18′ N, 79°51′ E) in Tamil Nadu, with the Bay of Bengal to the east, Palk Strait to the south and salt pans and marshes on the north and west, is a major wintering waterfowl refuge in India (Ali 1963). It attracts a large number of migratory waterfowl. The Bombay Natural History Society has been ringing waterfowl and landbirds over several years at Pt. Calimere (Ali and Hussain 1981-1982). A checklist of birds both observed as well as ringed at Pt. Calimere has been published (Sugathan 1982). This paper deals with two aspects of ornithological studies at Pt. Calimere: firstly bird ringing activities, and secondly census data.

BIRD RINGING ACTIVITIES
MATERIAL AND METHODS

The present paper deals only with the waterfowl ringing and census studies during the year 1985-86. For the trapping of waterfowl, experienced trappers from a local village were employed, and used traditional methods such as hand-made meshnets, clap traps and nooses for catching birds. The birds were identified, ringed and aged according to Prater *et al.* (1977).

The physical measurements of birds were taken according to the standard techniques (Spencer 1976). After taking measurements and noting the moult status, the birds were released at the place of capture. The results of the moult study will be published elsewhere.

RESULTS AND DISCUSSION

To date, 243 species of migratory and resident birds have been recorded. The total number of birds ringed for the past six years is given in Table 1. The populations of landbirds and waterbirds fluctuate each year depending on climatic conditions and the availability of food. During eight months of ringing operations in 1985-86, 5321 waterbirds of 38 species were caught and ringed.

The little stint *Calidris minuta*, followed by ruff and reeve *Philomachus pugnax* and curlew sandpiper *Calidris ferruginea* were the commonest birds ringed in 1985-86. The monthwise totals for each species are shown in Table 2. A peak in total number of birds ringed was seen in December and the minimum number in April.

TABLE 1
YEARWISE RINGING OF BIRDS AT PT. CALIMERE

Year	Number of birds	
	Landbirds	Waterbirds
1980-81	7553	18456
1981-82	2499	9775
1982-83	3203	10259
1983-84	643	7846
1984-85	1493	7448
1985-86	1439	5321
Total	16830	59105

[1] Accepted June 1991.

[2] Bombay Natural History Society, Hornbill House, Shaheed Bhagat Singh Road, Bombay 400 023.

Table 2

NUMBER OF WATERBIRDS RINGED IN 1985-86 AT PT. CALIMERE (4 SEPTEMBER 1985 TO 21 APRIL 1986)

Species	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
Ardeola grayii			7	9			7	4	27
Ardeola striatus							2		2
Bubulcus ibis		2	6						8
Egretta garzetta			1						1
Phoenicopterus roseus	1								1
Anas acuta				1	2		1		4
Anas crecca							1	1	2
Anas querquedula			1						1
Anas clypeata				1	3	4			8
Amaurornis phoenicurus							5	3	8
Charadrius leschenaultii				1					1
Charadrius alexandrinus				5		1	1		7
Charadrius mongolus	2	2	23	1		4		5	37
Numenius phaeopus			1						1
Numenius arquata				1				2	3
Limosa limosa				2					2
Tringa totanus	1		3	2	4	1			11
Tringa stagnatilis		7	2	31	1		8		49
Tringa nebularia			3						3
Tringa glareola		6		36			2		44
Tringa terek			1	1					2
Tringa hypoleucos							1		1
Arenaria interpres			1				1		2
Gallinago stenura							1		1
Calidris minuta	822	531	529	813	376	806	454	169	4500
Calidris alpina	1	1	3	4	4	3			16
Calidris ferruginea	44	47	22	85	6		9	3	216
Limicola falcinellus		1	10						11
Philomachus pugnax	6	7	77	194					284
Phalaropus lobatus		17	2	1					20
Recurvirostra avosetta					2				2
Larus argentatus					4	8	4		16
Larus brunnicephalus					2	3	7	1	13
Larus ridibundus						1			1
Chlidonias hybrida			4						4
Sterna hirundo	2		2						4
Sterna albifrons			4						4
Sterna bergii			4						4
All species combined	879	621	706	1188	404	831	504	188	5321

Recapture profile: In total, 104 birds of five different species were recaptured during the year. The maximum number of recaptures were of *Calidris minuta* (91) followed by *Calidris ferruginea* (6), lesser sand plover *Charadrius mongolus* (3), *Philomachus pugnax* (2) and redshank *Tringa totanus* (2) (Table 3). Four *Calidris minuta* were recaptured after five years. Two *Calidris ferruginea* were recaptured after two years and a *Philomachus pugnax* after four years. Two interesting recoveries were obtained of birds ringed elsewhere, *Calidris minuta* with Moskwa ring No.K 450382 replaced by BNHS ring No. A. 230789 on 6 March 1986, and *Philomachus pugnax* (MB 023023 replaced by B. 48807) on 26 September 1985. The ringing details obtained from Moskwa for the *Calidris minuta* show that it was ringed on 29 August 1982 in Sorbulak lake,

TABLE 3
RECAPTURE DETAILS OF WATERBIRDS AT PT. CALIMERE (1985-86)

No.	Ring No.	Date of ringing	Wt. (g)	Location	Recapture date	Wt. (g)	Location	Time interval years	months	days
Calidris minuta - A (Ring size)										
1.	220392	1 Mar '85	22	Pump House-1	4 Sep '85	24	MN Bund	–	6	8
2.	206294	21 Jan '83	23	Retta Theevu	5 Sep '85	21.5	MN Bund	2	7	18
3.	206041	18 Jan '83	24	MN Bund	6 Sep '85	24	"	2	7	23
4.	220555	16 Mar '85	24	"	6 Sep '85	25	"	–	5	25
5.	199258	16 Nov '82	22	Pump House-3	7 Sep '85	24	MN Bund	2	9	27
6.	220149	21 Jan '85	24	Pump House-2	10 Sep'85	27	"	–	7	23
7.	220794	6 Sep '85	22	"	10 Sep'85	20.5	"	–	–	5
8.	220844	9 Sep '85	22	"	14 Sep'85	25	"	–	–	6
9.	213698	14 Nov'84	21	C. Plantation	14 Sep'85	24.5	"	–	10	5
10.	213452	8 Nov '84	20	C. Plantation	14 Sep'85	25	"	–	10	11
11.	182464	24 Feb '81	18	Manal Vaikal	16 Sep'85	20	"	4	6	26
12.	199945	16 Dec '82	20	Neduntheevu	17 Sep'85	22	"	2	9	7
13.	213598	10 Nov '84	21	C. Plantation	17 Sep'85	20	"	–	10	29
14.	220931	11 Sep'85	19	C. Plantation	17 Sep'85	–	"	–	–	7
15.	213302	5 Nov '84	20	Mariamman koil	24 Sep'85	20.5	Neduntheevu	–	10	24
16.	213457	8 Nov '84	23	C. Plantation	24 Sep'85	23	Neduntheevu	–	10	21
17.	213987	10 Dec'84	24	Retta Theevu	26 Sep'85	25.5	MN Bund	–	9	21
18.	220452	6 Mar '85	20	MN Bund	29 Sep'85	22	"	–	6	28
19.	196970	21 Aug'82	22	"	29 Sep'85	22	"	3	1	11
20.	169848	27 Sep'80	24	–	29 Sep'85	21.5	"	5	–	4
21.	213602	30 Nov'84	20	–	11 Oct'85	20	MN Bund	–	10	16
22.	223557	1 Oct'85	23.5	MN Bund	12 Oct'85	28	MN Bund	–	–	12
23.	205729	15 Nov'83	27	Pump House-2	14 Oct'85	23	"	1	10	29
24.	220938	12 Sep'85	25	MN Bund	17 Oct'85	23	"	–	1	6
25.	179037	12 Dec'80	23	Pump House-3	21 Oct'85	25.5	"	4	10	15
26.	206580	27 Jan'83	23	MN Bund	24 Oct'85	24.5	"	2	9	2
27.	214065	13 Dec'84	23	Kutnikkadu	26 Oct'85	22.5	"	–	10	17
28.	223325	21 Sep'85	17.5	MN Bund	26 Oct'85	21	"	–	1	6

TABLE 3 (contd.)

No.	Ring No.	Date of ringing	Wt. (g)	Location	Recapture date	Wt. (g)	Location	Time interval years	months	days
29.	207488	4 Mar '85	24	Pump House-2	5 Nov'85	23	C. Plantation	2	8	8
30.	220920	11 Sep'85	24.5	MN Bund	14 Nov'85	24	Mariamman Koil	–	2	5
31.	209905	10 Oct'85	21	Neduntheevu	15 Nov'85	21	"	–	1	7
32.	223803	16 Oct'85	21	MN Bund	16 Nov'85	20	"	–	61	2
33.	193382	3 Dec'81	19	Pump House-3	16 Nov'85	19	"	3	11	20
34.	185403	23 Sep'81	24	Retta Theevu	20 Nov'85	24	Pump house-1	4	2	–
35.	203476	12 Jan'84	24.5	Mariamman koil	20 Nov'85	22	"	1	10	14
36.	220343	28 Feb'85	23	Mariamman Koil	20 Nov'85	24	"	–	8	26
37.	220309	27 Feb'85	21	MN Bund	20 Nov'85	23	"	–	8	27
38.	212660	17 Oct'85	22	MN Bund	27 Nov'85	26	Neduntheevu	–	1	12
39.	203373	1 Mar '85	–	Pump House-2	27 Nov'85	31	"	–	9	2
40.	214947	19 Jan'85	19	MN Bund	9 Dec'85	20	Mariamman Koil	–	10	24
41.	219975	15 Feb'85	20	Neduntheevu	11 Dec'85	20	MN Bund	–	10	–
42.	224753	6 Dec'85	23	Mariamman Koil	16 Dec'85	26	"	–	–	11
43.	214201	19 Dec'84	23	Mariamman Koil	27 Dec'85	24	MN Bund	1	–	9
44.	226016	14 Dec'85	29	MN Bund	31 Dec'85	22	Mariamman Koil	–	–	18
45.	224872	9 Dec'85	17	Mariamman Koil	31 Dec'85	23	"	–	–	23
46.	224164	15 Nov'85	28.5	"	2 Jan'86	26	"	–	1	19
47.	224186	16 Nov'85	19	"	6 Jan'86	19	"	–	1	22
48.	223718	12 Oct'85	26	MN Bund	6 Jan'86	24	MN Bund	–	2	26
49.	214556	31 Dec'84	20	Pump House-2	6 Jan'86	24	"	–	–	7
50.	224876	9 Dec'85	22	Mariamman Koil	8 Jan'86	22	"	–	1	1
51.	220081	19 Feb'85	24	MN Bund	10 Jan'86	22	"	–	10	26
52.	213037	26 Oct'84	20	"	24 Jan'86	22	"	1	3	1
53.	212162	2 Oct'84	24	"	7 Feb'86	20	Pump house-3	1	3	7
54.	169757	26 Sep'80	22	"	7 Feb'86	24	"	5	4	15
55.	205872	17 Nov'83	24.5	C. Plantation	7 Feb'86	23	"	2	2	24
56.	223712	12 Oct'85	20	MN Bund	7 Feb'86	21	"	–	3	28
57.	223437	28 Sep'85	20	"	11 Feb'86	23	"	–	4	17
58.	211775	17 Sep'84	26	Retta Theevu	11 Feb'86	19	"	1	4	28
59.	205014	22 Oct'83	16	–	12 Feb'86	22	"	2	3	24
60.	209800	6 Oct'83	29	Pump House-2	15 Feb'86	22	N of MN Bund	2	4	13

TABLE 3 (contd.)

No.	Ring No.	Date of ringing	Wt. (g)	Location	Recapture date	Wt. (g)	Location	Time interval years	months	days
61.	226783	25 Jan' 85	19	Pump House-2	15 Feb'86	21	"	–	–	22
62.	223509	20 Sep' 85	19.5	MN Bund	15 Feb'86	20	"	–	4	20
63.	211396	9 Mar '84	24	Kutnikkadu	19 Feb'86	22.5	"	1	11	19
64.	224933	11 Dec'85	24	MN Bund	19 Feb'86	25	"	–	2	10
65.	230167	15 Feb'86	24	North of MCIC	19 Feb'86	24	"	–	–	5
66.	178008	20 Nov'80	19	Light House	19 Feb'86	23	"	5	3	3
67.	211684	13 Sep'84	23	MN Bund	22 Feb'86	21	North of MCIC	1	5	13
68.	213435	8 Nov'84	21	C.Plantation	22 Feb'86	21	"	1	3	17
69.	223622	10 Oct'85	21	MN Bund	22 Feb'86	21.5	"	–	4	16
70.	226341	28 Dec'85	23	MN Bund	22 Feb'86	19.5	"	–	1	27
71.	230417	24 Feb'86	21	North of MCIC	4 Mar' 86	21	MN Bund	–	–	9
72.	230571	25 Feb'86	27	"	5 Mar '86	25	"	–	–	9
73.	230720	5 Mar '86	20	"	8 Mar '86	19	"	–	–	4
74.	230392	22 Feb'86	23	"	8 Mar '86	20	"	–	–	15
75.	223718	12 Oct '85	26	MN Bund	8 Mar '86	21	"	–	4	28
76.	230459	24 Feb'86	27	North of MCIC	15 Mar '86	24	"	–	–	20
77.	230294	18 Feb'86	20	North of MN Bund	15 Mar '86	21	"	–	–	26
78.	197129	3 Sep'82	21	Pump House-2	24 Mar '8	25	"	3	6	24
79.	207529	7 Mar '83	23	Pump House-1	25 Mar '86	22	"	3	–	20
80.	230068	11 Feb'86	19	Pump House-3	31 Mar '86	22	"	–	1	19
81.	230818	7 Mar '86	19.5	North of MCIC	31 Mar '86	23	"	–	–	25
82	214541	31 Dec'84	22	"	1 Apr '86	21	"	1	3	2
83.	230876	8 Mar '86	20	"	2 Apr '86	22	"	–	–	26
84.	223336	21 Sep'86	22.5	MN Bund	2 Apr '86	29.5	"	–	6	14
85.	230856	8 Mar '86	22	North of MCIC	4 Apr '86	30	"	–	–	28
86.	213677	14 Nov'84	18	C.Plantation	5 Apr '86	19	"	1	4	23
87.	181898	7 Feb'81	21	Neduntheevu	5 Apr '86	26	MN Bund	5	1	29
88.	193108	24 Nov'81	20	MN Bund	8 Apr '86	21	MN Bund	4	4	17
89.	205316	30 Oct'83	20	Neduntheevu	8 Apr '86	–	"	2	5	12
90.	230912	13 Mar'86	20	North of MCIC	8 Apr '86	20.5	"	–	–	27
91.	216736	4 Apr '86	22	MN Bund	11 Apr '86	25	"	–	–	8

4

TABLE 3 (contd.)

No.	Ring No.	Date of ringing	Wt. (g)	Location	Recapture date	Wt. (g)	Location	Time interval years	months	days
Calidris ferruginea- AB (Ring size)										
1.	119366	21 Mar '85	53	Kutnikkadu	11 Oct'85	44	MN Bund	–	6	25
2.	108335	25 Sep'84	60	Kutnikkadu	14 Oct'85	45	MN Bund	1	–	20
3.	106582	26 Aug'83	54	Pump House-2	24 Oct'85	49	"	2	2	1
4.	102865	23 Feb'83	52	Pump House-2	31 Oct'85	45	C. P lantation	2	8	12
5.	119130	6 Feb '85	60	North of PH-2	12 Dec '85	56	MN Bund	–	10	10
6.	119561	29 Sep'85	54	MN Bund	21 Mar '86	67	MN Bund	–	5	24
Philomachus pugnax - B (Ring size)										
1.	36763	6 Jan '83	82	Kutnikadu	16 Dec '85	96	MN Bund	2	11	16
2.	35763	24 Nov '81	90	MN Bund	17 Dec '85	107	MN Bund	4	–	25
Charadrius mongolus - AB (Ring size)										
1.	112141	30 Nov '83	63	C. Plantation	16 Nov '85	–	Mariamman Koil	1	11	23
2.	119678	20 Nov '85	46	Pump House -1	22 Nov '85	47	Mariamman Koil	–	–	3
3.	113802	17 Oct '83	42	Neduntheevu	10 Apr '86	43	MN Bund	2	5	27
Tringa totanus - B (Ring size)										
1.	48769	17 Mar '85	140	Kutnikadu	15 Nov '85	105	Mariamman Koil	–	8	4
2.	36799	21 Jan '83	93	Kutnikadu	2 Jan '86	109	Mariamman koil	2	11	18

C. Plantation = Casuarina plantation, PH-2 =Pump House 2, MCIC = Mettur Chemical and Industrial Corporation Ltd.

Alma-Ata region, Kazakhstan, U.S.S.R (43°46′ N, 76°05′ E). The ring was recovered after 1285 days (3 years, 6 months, 10 days) at Pt. Calimere.

Morphometry: The biometrics of eight species were studied (Table 4). During the ringing sessions measurements such as wing length, bill length, tarsus and tail length were taken. In species with small samples, all the measurements were used for analysis, whereas in the case of larger samples such as *Calidris minuta*, 100 samples each from adult and juvenile birds were used. Minimum and maximum measurements of wing, bill, tarsus and tail were recorded for each species for both juveniles and adults.

An attempt was made to correlate the wing/tarsus ratio to determine racial variation, as in the case of *Charadrius mongolus*, where adults with wing/tarsus ratio below 4.09 are believed to belong to the *atrifrons* group (Cramp and Simmons 1982). The analysis of wing/tarsus ratio of *Charadrius mongolus* indicates that the majority visiting Pt. Calimere fall under the *atrifrons* group (wing/tarsus ratio = 4.01). However, individual analysis of wing/tarsus ratio and plumage characters suggests the possible occurrence of four subspecies of *Charadrius mongolus* at Pt. Calimere (Balachandran and Natarajan 1992).

Seasonality, Diversity and Density of Waterbirds

Methodology

A one kilometre long reservoir with a bund starting and running west from Pump House No.2 (owned by Mettur Chemical and Industrial Corporation) (now Chemplast) was selected for censusing waterbirds. On either side of the bund large condensers filled with salt water provide feeding and roosting areas for many waterbirds. The right side reservoir is active and the water level is maintained constant, whereas in the left reservoir the water level fluctuates widely. Half the left reservoir has been abandoned and dries up completely during summer.

Birds were censused using the fixed-width transect method (Emlen 1971). The birds observed within 200 m on either side of the transect were counted using binoculars and telescope. The bird census was carried out during the morning on alternate days. The bird density (D) was calculated as D = n/2LW, where n is the number of observations within the strip of width W and transect length L (Franzreb 1981). Bird species diversity (H) was calculated using the formula

$$H = -\sum_{i=1}^{n} p_i \ln p_i$$

where p_i is the proportion of individuals in the 'ith' category (MacArthur *et al.* 1966).

Results and Discussion

49 species of birds belonging to six orders were recorded during the census operation, including nine species of landbirds frequently sighted in the study area. The species richness (number of species recorded) varied during different months, with the maximum in September-October 1985 and the minimum in June 1986 (Table 5).

Seasonal Population Fluctuation

The little egret *Egretta garzetta* and painted stork *Mycteria leucocephala* were present throughout the year. Terns, such as the Caspian tern *Hydroprogne caspia*, whiskered tern *Chlidonias hybrida*, and little tern *Sterna albifrons* were also regularly present in the area. There were only a few sightings of species like lesser flamingo *Phoeniconaias minor*, and certain species of ducks. Monthly averages of the birds censused are given in Table 6.

Spotted-billed pelican *Pelecanus philippensis:* The pelicans arrive during September. Their number increases progressively, reaching a peak in December, then suddenly decreases in January, reaching a minimum level in February and March. The birds disappear thereafter. The main reason for the constant increase from October onwards is the stopping of pumping activity by the chemical company and the rainfall, which lowers salinity in the reservoir and presumably thereby increases the fish population, providing enough food for the birds.

Grey heron *Ardea cinerea:* A small resident population was recorded almost throughout the

TABLE 4
MEASUREMENTS OF EIGHT SPECIES OF BIRDS RINGED AT PT. CALIMERE

	Sample size	Range	Mean
	Charadrius mongolus		
Wing (mm)	10 A	123-131	126.3
	11 J	118-130	123.9
Bill (mm)	17 A	17-20	18.8
	12 J	16.5-20.5	18.6
Tarsus (mm)	16 A	28-35	31.5
	14 J	28-35	31.3
Tai (mm)	15 A	50-54	51.1
	12 J	42-51	46.5
Weight (g)	17 A	42-54	47.4
	14 J	40-54	47.6
Adult wing / tarsus ratio = 4.01			
	Tringa totanus		
Wing (mm)	8 A	149-163	157.9
Bill (mm)	8 A	41-46	43.5
Tarsus (mm)	8 A	42-51	47.1
Tail (mm)	8 A	58-68	64.3
Weight (g)	8 A	90-140	116.4
	Tringa stagnatilis		
Wing (mm)	20 A	131-152	139.4
	8 J	136-142	139.5
Bill (mm)	20 A	37-45	40.8
	8 J	39-46	43.1
Tarsus (mm):	20 A	44-59	50.8
	7 J	48-58.5	53.9
Tail (mm):	20 A	53-66	59.4
	7 J	55-61	58.7
Weight (g):	20 A	48-82	59.7
	8 J	71-84	75
	Calidris minuta		
Wing (mm)	96 A	92-107	97.3
	100 J	92-103	98.1
Bill (mm)	99 A	16-21	18.9
	100 J	16-20	18.9
Tarsus (mm)	99 A	18-23	20.4
	100 J	18-22	20.3
Tail (mm)	99 A	33-44	40.2
	99 J	36-42	39.9
Weight (g)	99 A	19-28	22.5
	100 J	18-27.5	21.4
	Calidris ferruginea		
Wing (mm)	43 A	123-138	130.3
	50 J	124-135	129.7
Bill (mm)	77 A	31-45	38.3
	50 J	27-42	37.3
Tarsus (mm)	76 A	26-33	29.3
	48 J	24-32	29.2
Tail (mm)	70 A	42-53	48
	44 J	41-49	45.7
Weight (g)	80 A	44-62	52.2
	50 J	44-84	54.4
	Calidris alpina		
Wing (mm)	3 A	115-123	120.3
	12 J	115-123	119.4
Bill (mm)	3 A	31-35	33.7
	13 J	30-38	33.3
Tarsus(mm)	3 A	22-25	23.7
	13 J	21-26.5	24
Tail (mm)	3 A	47-54	51
	11 J	46-53	50
Weight (g)	3 A	43-48	45.7
	12 J	39-54	46.2
	Limicola falcinellus		
Wing (mm)	8 A	107-111	107.3
Bill(mm)	11 A	30-34	31.6
Tarsus(mm)	11 A	20-23	20.5
Tail (mm)	11 A	37-42	39.6
Weight (g)	11 A	24-34	30.1
	Philomachus pugnax, female		
Wing (mm)	38 A	150-167	156.4
	19 J	150-163	157.3
Bill (mm)	52 A	27.5-32	30.3
	16 J	28-32	30.1
Tarsus (mm)	53 A	35-44	39.2
	16 J	35-42	38.8
Tail (mm)	53 A	52-71	57.5
	18 J	54-60	57.3
Weight (g)	57 A	80-116	102.8
	19 J	91-114	105.3
	Philomachus pugnax, male		
Wing (mm)	3 A	186-189	187.3
Bill (mm)	9 A	31-38	35.6
Tarsus (mm)	9 A	45-50	48.2
Tail (mm)	9 A	67-72	69.6
Weight (g)	9 A	148-187	169.9

A – adult, J – Juvenile (first year bird)

census studies. There was no peak or fall worth noting. Breeding in some islets in the swamp.

Little egret *Egretta garzetta:* Recorded throughout the census period. Two main peaks, in August and April, were observed, followed by a slight peak in June. The population was very low during October-November.

Indian reef heron *Egretta gularis:* A seasonal migrant, recorded only from October to May.

Redshank *Tringa totanus:* This migrant was seen from August to November, then reappeared after a break of two months. A peak was observed in February and was seen up to March. Thereafter in April, May and June it was not recorded.

Greenshank *Tringa nebularia:* Trends similar to those for the redshank, except for its absence from May to July.

Little stint *Calidris minuta:* The commonest species at Pt. Calimere, but present in small numbers from August till December. A sudden increase in January and decline in February, with a slow increase through March, reaching a second peak in April. The species was absent from May to July.

Curlew sandpiper *Calidris ferruginea:* Occurred in almost all months except February, May and June. The maximum population was recorded during October and a very high congregation was seen during July. Interestingly, there was a high population in April, followed by a complete absence during May and June and again a very high peak in July.

Herring gull *Larus argentatus:* The first among the gulls to reach Pt. Calimere, but was not common in the census area. A small population was noticed during September, October and January. They preferred the sea shore as it provided large amounts of fishery waste on which they fed.

Brownheaded gull *Larus brunnicephalus:* The commonest gull in the swamps of Pt. Calimere, noted from October till May, reaching a peak during January. A sudden decline in February, followed by a second peak in March and then a decline in May.

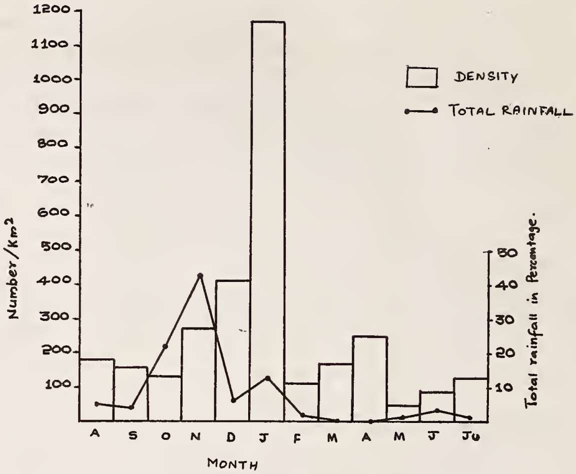

Fig. 1. Monthly variation in density of waterbirds during 1985-86 at Pt. Calimere

Whiskered tern Chklidonias hybrida: Fairly comon in the swamp habitat, usually present throughout the year.

Common tern *Sterna hirundo:* Recorded throughout the census period with a peak in August, thereafter showing a constant decline, reaching a minimum in October.

Little tern *Sterna albifrons:* A breeding resident of Pt. Calimere, present throughout the year with slight variations in numbers every month.

Swallow *Hirundo rustica:* Even though they are landbirds they prefer swamp habitat for both feeding and roosting. First recorded in September

Table 5

BIRD SPECIES DIVERSITY AND SPECIES RICHNESS

Month	Bird species diversity	No. of species
August 1985	2.03	19
September	2.40	29
October	2.04	29
November	1.85	25
December	2.16	22
January 1986	1.59	26
February	2.04	23
March	1.88	24
April	2.01	27
May	2.34	22
June	1.87	13
July	1.94	20

TABLE 6
MONTHLY AVERAGES OF WATERBIRDS CENSUSED IN 1985-'86

Species	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Pelecanus philippensis	–	2.8	4.8	11.6	16.6	1.9	P	P	–	–	–	–
Ardea cinerea	2.7	–	P	–	2.7	P	P	1.8	2..6	P	3.5	2.1
Ardeola grayii	P	–	P	P	5	2.1	2.9	5.3	8.5	2.4	–	–
Ardea alba	P	–	–	2.1	2.8	1.9	4.1	1.7	2	–	–	–
Egretta intermedia	–	P	P	–	–	–	–	–	P	P	–	–
Egretta garzetta	23.1	13.5	3.4	1.6	6.2	5.5	13.0	13.8	27.5	5.1	14	5.3
Egretta gularis	–	–	P	P	2.7	1.2	2.6	4.6	2.8	P	–	–
Mycteria leucocephala	23.9	10.3	8.3	2.8	9.3	2.5	P	P	10.0	3.5	14.8	25.1
Platalea leucorodia	–	–	2.6	3.4	–	–	–	–	–	–	–	–
Phoenicopterus roseus	–	24.8	1	21.8	–	199.2	–	–	–	–	–	–
Phoeniconaias minor	–	–	–	–	–	–	–	–	–	P	–	–
Anas acuta	–	–	–	–	–	388.5	–	–	–	–	–	–
Anas poecilorhyncha	–	–	–	–	–	–	–	–	–	–	–	P
Anas clypeata	–	–	–	–		109.2						
Himantopus himantopus	–	–	–	–	89.9	–	–	–	–	P	–	–
Recurvirostra avosetta	–	–	–	41.8	–	–	–	–	–	–	9	23.5
Pluvialis squatarola	P	–	P	–	–	–	–	–	–	–	–	–
Charadrius dubius	–	P	–	P	–	–	–	–	–	–	–	–
Charadrius alexandrinus	P	P	1.2	–	–	–	P	P	P	–	–	–
Charadrius mongolus	1.1	1.4	2.1	–	–	–	–	–	–	–	–	–
Numenius phaeopus	–	P	–	–	–	–	–	–	–	–	–	–
Tringa totanus	P	P	P	P	–	–	1.2	P	–	–	–	1.4
Tringa stagnatilis	–	P	P	–	40.4	4.6	2.2	1.1	P	P	–	P
Tringa nebularia	P	P	P	–	–	–	P	P	P	–	–	–
Tringa terek	1	P	–	–	–	–	P	–	2.1	P	–	–
Tringa hypoleucos	–	–	–	–	–	–	P	–	P	–	–	P
Arenaria interpres	–	–	–	–	–	–	–	–	P	P	–	–
Calidris minuta	46.7	28.2	47.6	4	38.8	171.2	31.6	55.3	90.5	45	–	P

TABLE 6 (contd.)

Species	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Calidris ferruginea	10.9	8	11.4	P	P	P	–	1.7	14.3	–	–	29.1
Philomachus pugnax	–	P	–	–	15.5	–	–	–	–	–	–	–
Phalaropus lobatus	–	–	–	–	–	–	P	–	–	–	–	–
Larus argentatus	–	P	P	–	–	P	–	–	–	–	–	–
Larus fuscus	–	–	–	P	–	–	–	–	–	–	–	–
Larus brunnicephalus	–	–	P	P	4.9	36.2	16.2	31.3	18.2	1.8	–	–
Larus ridibundus -	–	–	–	1.4	–	–	–	–	–	–	–	–
Chlidonias hybrida	5.3	6.5	6.2	P	–	P	5.1	8.5	2.9	P	P	P
Gelochelidon nilotica	9.9	1.8	P	P	1.2	P	P	P	P	–	P	–
Hydroprogne caspia	3.4	8.7	6.2	1.7	1.6	P	P	P	1	10.1	20	10
Sterna hirundo	11.3	8.6	P	P	2.2	1.5	P	P	P	P	P	P
Sterna albifrons	P	2.8	1.6	2.8	2.2	1.7	P	P	2.8	P	1.5	3.9
Landbirds												
Haliastur indus	–	4.7	1.9	3	2.5	3.4	3.1	2.6	4.5	2.3	2.5	4.0
Cypsiurus parvus	–	–	–	12.5	7.2	–	–	P	–	–	P	P
Ceryle rudis	–	P	P	–	–	–	–	P	–	P	P	P
Alcedo atthis	–	P	P	P	P	–	–	–	P	–	–	P
Halcyon smyrnensis	–	–	–	–	P	P	–	–	P	P	–	P
Hirundo rustica	–	–	–	98.2	72.5	P	–	–	–	–	–	–
Corvus splendens	–	P	P	–	–	3.7	P	P	3.8	1.8	1.3	1.4
Corvus macrorhynchos	P	P	–	–	–	P	–	–	P	–	–	–
Motacilla maderaspatensis	–	P	P	–	–	P	P	P	P	–	–	–

P = Mean of less than 1

TABLE 7
POPULATION DENSITY OF WATERBIRDS AT PT. CALIMERE (AUGUST 1985 – JULY 1986)

Species	Status	Density/ sq. km
Pelecanus philippensis	SM	8
Ardea cinerea	R	4
Ardeola grayii	C	6
Ardea alba	C	3
Dgretta intermedia	C	1
Egretta garzetta	C	28
Egretta gularis	C	3
Mycteria leucocephala	C	23
Platalea leucorodia	SM	1
Phoenicopterus roseus	SM	52
Phoeniconaias minor	SM	1
Anas acuta	M	81
Anas poecilorhyncha	SM	1
Anas clypeata	M	23
Himantopus himantopus	SM	19
Recurvirostra avosetta	M	16
Pluvialis squatarola	M, C	1
Charadrius dubius	C, R	1
Charadrius alexandrinus	C, R	1
Charadrius mongolus	M, C	1
Numenius phaeopus	M, C	1
Tringa totanus	M, C	1
Tringa stagnatilis	M, C	10
Tringa nebularia	M, C	1
Tringa terek	*M*	*1*
Tringa hypoleucos	M, C	1
Arenaria interpres	M, C	1
Calidris minuta	M, C	108
Calidris ferruginea	M, C	16
Philomachus pugnax	M, C	3
Phalaropus lobatus	M, O	1
Larus argentatus	M, C	1
Larus fuscus	M, C	1
Larus brunnicephalus	M, C	23
Larus ridibundus	M, C	1
Chlidonias hybrida	M, C	8
Gelochelidon nilotica	M, C	3
Hydroprogne caspia	M, C	13
Sterna hirundo	M, C	6
Sterna albifrons	R, B	4

B = breeding, C = common, R = resident, M = migrant, SM = seasonal migrant, O = occasional.

but completely absent in October. A large influx was noted during November; the population remained stable throughout December and decreased in January, after which they disappeared from the area. Three interesting recoveries were obtained during 1986: birds ringed at Mootpuzha in Kerala were captured by false vampire bats in Tamil Nadu during November, suggesting an eastward movement of this species during migration (Sugathan 1988).

Brahminy kite *Haliastur indus:* There was not much variation in population size, which remained almost constant throughout the year except during August. A breeding resident, commonly seen in good numbers on the seashore from November to February (the fishing season). Feeds on fishery waste, along with gulls.

Bird species diversity: The mean monthly bird species diversity was 2.01. The monthly variation of the diversity is shown in Table 5.

Density of waterbirds: The status and density of waterbirds estimated per sq. km are given in Table 7. Monthly variations in density are shown in Fig. 1. The annual mean bird density (all species) was 516 birds/sq. km. The density was highest in January, lowest in May and increased after the rains (Fig. 1).

The census data was gathered mainly from reservoirs (man-made habitat), which attract large numbers of piscivorous birds rather than waders. The figures for natural habitat may be significantly different.

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PARASITIC WASPS OF THE GENUS *TETRASTICHUS* HALIDAY (HYMENOPTERA: EULOPHIDAE) FROM NORTHERN INDIA[1]

M. A. KHAN AND S. N. SUSHIL[2]

(With seventy-four text-figures)

Tetrastichus Haliday, 1843

Genotype: *Cirrospilus attatus* Walker by original designation [= *miser* (Nees)].

The genus *Tetrastichus* Haliday is a useful member of the Chalcidoidea which attacks a wide variety of hosts, including important pests of agriculture crops such as caterpillars, stem-borers, leaf miners, aphids, beetles, midges and thrips. The parasites attack different stages of the host including eggs, larvae, nymphs and pupae. They are either primary parasites or hyperparasites. Some species of *Tetrastichus* have also been reared as secondary parasites.

From India a good number of species have been described. In the present work five new species are being added to the known species of the genus *Tetrastichus* and three species are redescribed. (Type material is being deposited in Z.S.I., Calcutta, India). A key to some Indian species of the genus is also given .

KEY TO SOME INDIAN SPECIES OF THE GENUS *Tetrastichus* HALIDAY BASED ON FEMALES

1. Post marginal vein distinctly developed 2
— Post marginal vein completely absent 7
2. Body yellow or yellowish brown 4
— Body black 3
3. Frontovertex and face with scattered shallow punctations; eyes very sparsely pubescent; antennae brown, scape pale brown, only one ring segment present, club almost as long as preceding two funicle segments combined, scutellum finely longitudinally reticulate .... *T. krishnaiahi* Kaul and Saraswat
— Area of frons dorsad and laterad of scrobe cavity deeply punctured; eyes bare; antennae brown except club white and scape whitish with infuscation on dorsal side, three ring segments present, club longer than preceding funicle segment; scutellum with micro-reticulate sculpture .... *T. chakrataensis* sp. nov.
4. Eyes black or dark red 5
— Eyes silvery white, bare, scape slightly more than four times as long as wide, three ring segments present; funicle segments 1-3 subequal in length, each one and a half times as long as wide; mesoscutum with five setae near each parapsidal furrow, abdomen with five transverse brown bands on dorsum .... *T. flavidus* Khan and Shafee, 1981
5. Eyes smooth, black in colouration, frontovertex smooth 6
— Eyes pubescent, dark red; abdomen with transverse bands; frontovertex punctate, propodeum smooth, median carina and paraspiracular carina absent, propodeal spiracle touching the lateral margin .... *T. postmarginaloides* Saraswat
6. Post ocellar line distinctly less than twice as long as ocellocular, antennae with only one ring segment, pedicel short, longer than wide, first funicle segment longer than wide, second segment shorter than first, quadrate, third segment transverse, wider than long, club almost as long as funicle segments 1-3 combined .... *T. mohani* sp. nov.
— Post ocellar line greater than ocellocular, antennae with only two ring segments, pedicel twice as long as wide, first funicle segment a trifle less than twice as long as wide, second segment longer than first, less than twice as long as wide, third segment short, less than one and a half times as long as wide, club longer than preceding two funicle segments combined...... .... *T. lotellae* Delucchi
7. Body colouration dark brown or metallic 8
— Body colouration yellow or yellowish brown 18
8. Antennae with only one ring segment 9
— Antennae with more than one ring segment 15
9. Frontovertex punctate 10
— Frontovertex smooth, without punctations 11
10. Malar suture distinct; antennae dark brown, scape testaceous, pedicel short, distinctly longer than wide, two ring segments present, funicle segments 1-3 subequal in size, club almost as long as preceeding two funicle segments together....................... .... *T. versicolor* Ranaweera, 1947

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— Malar suture absent, antennae dark brown except club white; pedicel long, more than twice as long as wide; only one ring segment present, first funicle segment elongated, less than twice as long as wide, second a trifle longer than wide, third greatly transverse, club longer than preceding two funicle segments combined . . . . *T. davidi* Khan *et al.*, 1986

11. Lower margin of clypeus with two dents medially . . . 12

— Lower margin of clypeus without dents medially; eyes red; prominence between antennal sockets one-third the width of frons between eyes; antennae uniformly yellowish brown. . . . . *T. indicus* Khan and Shafee, 1981

12. Antennae dark brown except scape yellowish or infuscated 13

— Antennae uniformly dark brown, except scape and pedicel white, prominence between antennal sockets more than one fifth the width of frons between eyes, subocular suture distinct, mandibles with an acute tooth and a truncation . . . . *T. partellus* sp. nov.

13. Mandibles tridentate 14

— Mandibles bidentate, post ocellar line almost one and a half times as long as ocellocular, prominence between antennal socket one fifth between the frons and eyes, malar suture absent, antennae dark brown except scape infuscated, pedicel distinctly less than twice as long as wide, mesopraescutum bearing one row of five setae at each lateral margin, third valvulae long, almost seven times as long as wide, distinctly less than one third the length of second valvifers . . . . *T. pyrillae* Crawford

14. Eyes reddish brown, prominence between antennal sockets one fourth the width of frons between eyes, malar space about as long as eye width, third valvulae short, triangular, less than twice as long as wide, about one fifth the length of second valvifers . . . . *T. aligarhensis* Khan and Shafee 1981

— Eyes dark, prominence between antennal sockets less than one third the width of frons between eyes, malar space distinctly longer than eye width, third valvulae long, lanceolate, almost four times as long as wide, more than one third the length of second valvifers. . . . . *T. mangifera* sp. nov.

15. Antennae with four ring segments. 16

— Antennae with only two or three ring segments . . . 17

16. Body very dark brown with metallic blue-green reflections; head without punctations; antennae brown with scape yellowish; legs pale yellow except fore coxae dark brown . . . . T. dhireni Saraswat

— Body non metallic brown; head with shallow scattered punctations on vertex and face, antennae dark brown except scape yellowish brown; legs pale brown. . . . . *T. shencottensis* Saraswat

17. Scape, pedicel yellowish brown, funicle segments and club fuscous; only two ring segments present, legs pale cream except coxae and major part of femora dark . . . . *T. taprobanensis* Ranaweera, 1947

— Antennae dark brown with yellow brown scape and pedicel; three ring segments present; legs testaceous except coxa and femora dark brown . . . . *T. niger* Ranaweera, 1947

18. Pedicel distinctly shorter or one-half to one-third the length of first funicle segment 19

— Pedicel as long as first funicle segment or longer . . . 27

19. Antennae with one or two ring segments 20

— Antennae with three or four ring segments 21

20. Antennae with only one ring segment, malar space shorter than eye width, mandibles with two teeth and truncation, scape three times longer than wide, basal vein with five setae, speculum closed below, third valvulae very long almost nine times as wide, distinctly less than one-third the length of second valvifers . . . . *T. pantnagarensis* Khan, 1983

— Antennae with two ring segments, malar space longer than eye width, mandibles tridentate with acute teeth; scape more than five times as long as wide; basal vein with three setae, speculum large and open below, third valvulae short, five times as long as wide, less than one fourth of the second valvifers . . . . *T. misellus* Delucchi

21. Four ring segments present 22

— Only three ring segments present 23

22. Antennae about half the body; pedicel almost one-third the length of first funicle segment; first funicle segment very long, almost eight times as long as wide; three mesoscutal bristles present, median longitudinal groove on mesonotum faint. . . . . *T. tritrichia* Saraswat

— Antennae less than half the body; pedicel not likewise, distinctly shorter than first funicle segment, first funicle segment almost two and a half times as long as wide; 11 mesoscutal bristles present, median longitudinal groove on mesonotum distinct . . . . *T. polyseta* Saraswat

23. Antennae not uniformly yellow 24

— Antennae uniformly yellow; eyes red with six dark patches; scape slightly less than four times as long as wide, as long as basal two funicle segments together, funicle segments 1-3 subequal in length, body completely yellow except apex of ovipositor infuscated; middle tibial spur as long as basitarsus; third valvulae four times as long as wide; one-fourth the length of second valvifers, outer plates of ovipositor as long as second valvifers . . . *T. psyllidis* Khan and Shafee, 1981

24. Lower margin of clypeus with two dents medially ... 25
— Lower margin of clypeus without dents medially; two dark spots below the front ocellus present; club two-segmented; thorax light reddish brown; slightly broader than head, legs yellowish brown; submarginal vein approximately equal to marginal vein; stigmal vein about one-fourth the marginal vein; ovipositor sub-exserted .... *T. lasiopterae* Bhatnagar, 1951
25. Frontovertex and thorax without any punctations ... 26
— Frontovertex, mesoscutum and scutellum with punctations; eyes and ocelli brownish red to reddish brown; antennae dark brown; legs yellowish brown except middle coxae completely, hind coxae basally and last tarsal segment of all the legs dark brown .... *T. malabarensis* Saraswat
26. Head yellowish brown, vertex and bases of ocelli dark brown, eyes reddish brown, antennae black except scape yellowish brown; legs yellowish except last tarsal segment of all the legs dark brown; pedicel distinctly less than one-half the length of first funicle segment .... *T. bicolor* Saraswat
— Head very dark brown, rest of the body yellowish brown; eyes red; antennae brown except scape and pedicel yellowish brown; legs brownish yellow except hind coxae on basal half black; pedicel not likewise but distinctly shorter than first funicle segment. .... *T. satpurensis* Saraswat
27. Eyes red or black 28
— Eyes silvery white; prominence between antennal sockets one-sixth the width of frons between eyes; antennae yellowish; scape three and a half times as long as wide; pedicel one and a half times as long as wide, two ring segments present; funicle segments 1-3 slightly longer than wide; third valvulae three and a half times as long as wide; one-third the length of second valvifers, outer plates of ovipositor slightly longer than second valvifers .... *T. ajmerensis* Khan and Shafee, 1981
28. Thorax yellowish brown; prominence between antennal sockets one-fifth the width of frons between eyes; mesoscutum with five setae near each parapsidal furrow, third valvulae six times as long as wide, more than one-third the length of second valvifers, outer plates of ovipositor as long as second valvifers ....*T. annulicornis* Khan and Shafee, 1981
— Thorax brown with reddish yellow admixture; prominence between antennal sockets distinctly more than one-fourth the width of frons between eyes; mesopraescutum bearing a single seta at each lateral margin, third valvulae less than six times as long as wide, slightly more than one-third the length of second valvifers, outer plates of ovipositor distinctly shorter than second valvifers .....*T. obliqua* sp. nov.

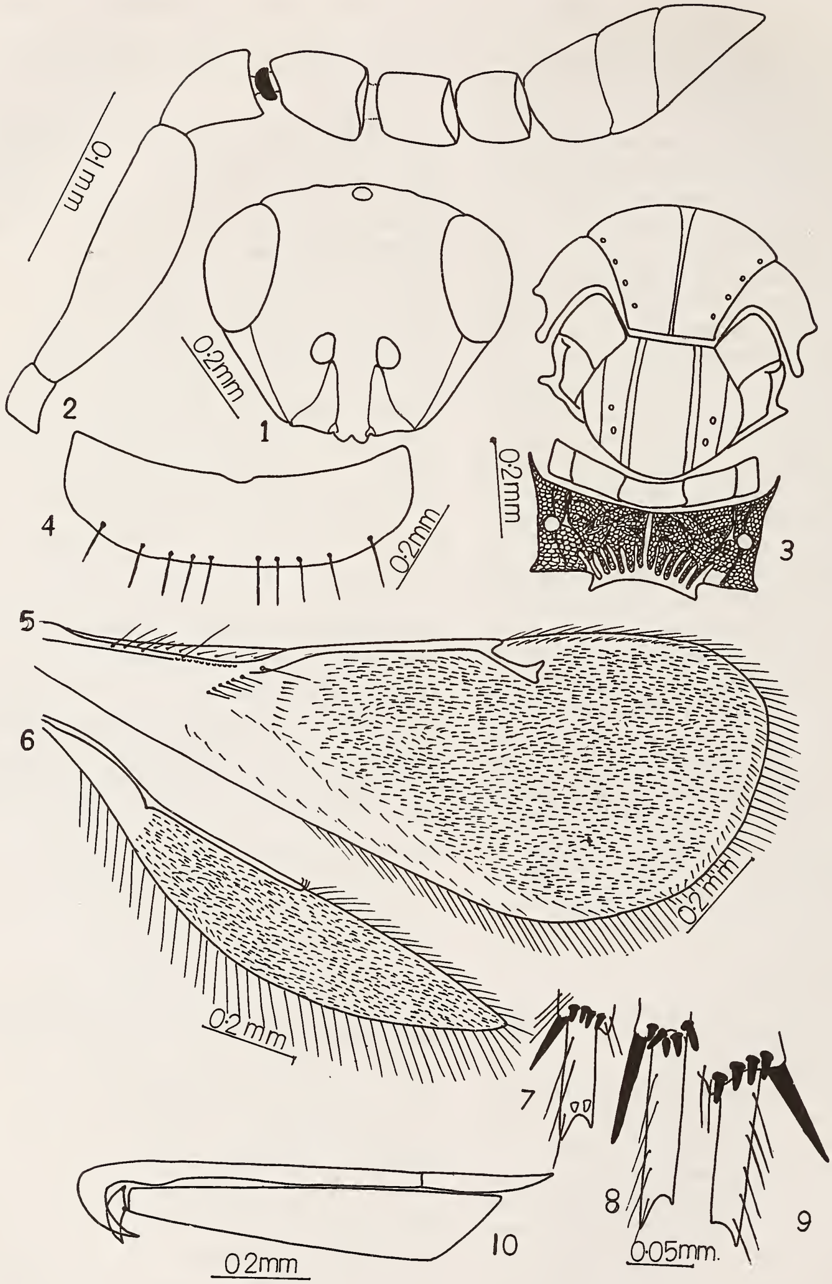
Tetrastichus mohani sp. nov.[3]
(Figs. 1-10)

Head (Fig. 1): Reddish brown, with very faint iridescent blue lustre, wider than long in facial view (0.64:0.52), frontovertex much wider, more than one-half the total head width (0.33:0.64); ocelli white, arranged in an obtuse angle triangle, post ocellar line distinctly less than twice as long as ocellocular; eyes black and smooth; antennae inserted just above the lower level of eyes; prominence between antennal sockets one-fourth the width of frons between eyes; malar space longer than eye width (0.21:0.14); malar suture distinct; lower margin of clypeus with two dents medially; mandibles tridentate, maxillary and labial palpi each segmented.

Antennae (Fig. 2): Yellowish brown except the scape whitish, 8-segmented excluding one ring segment; scape less than four times as long as wide (0.14:0.04), pedicel short, longer than wide (0.05:0.035), as long as first funicle segment, funicle 3-segmented, first funicle segment longer than wide (0.05:0.04), second segment shorter than first, quadrate (0.04:0.04), third segment transverse, wider than long (0.042:0.035), club 3-segmented, less than thrice as long as wide (0.13:0.055), almost as long as funicle segments 1-3 combined.

Thorax (Fig. 3): Reddish brown with very faint iridescent blue lustre; pronotum with posterior margin slightly concave with six pairs of setae, anterior margin concave in the middle (Fig. 4), mesoscutum distinctly more than twice as wide as long (0.6:0.26); parapsidal furrows complete, mesopraescutum bearing one row of four bristles at each lateral margin, median furrow present; scutellum wider than long (0.34:0.28), with two submedian grooves and two pairs of setae, posterior margin rounded,

[3]This species is named after Prof. Man Mohan Agarwal in recognition of his valuable contributions to our knowledge of Chalcidoidea.



Figs. 1-10. *Tetrastichus mohani* sp. nov.
1. Head, facial view; 2. Antenna; 3. Thorax; 4. Pronotum; 5. Forewing; 6. Hind wing; 7. Part of foreleg; 8. Part of middle leg; 9. Part of hind leg; 10. Ovipositor.

mesopostphragma not reaching beyond the propodeum; surface of propodeum with fine reticulate sculpture, strong mesal and paraspiracular carinae present and a series of short carinae radiating latero-anteriorad from posterior margin, a number of vague wrinkles present on propodeal surface, spiracles well separated from the anterior margin of propodeum.

Forewings (Fig. 5): Hyaline, less than thrice as long as wide (1.47:0.57), densely setose, rounded apically; costal cell broad with a ventral line of eight setae, basal vein with six setae, basal cell bare, speculum moderate and closed below, cubital vein sinuate, subcubital line of hairs starting from a distance about one-fourth distance from base; submarginal vein (0.46) with four strong setae, longer than marginal vein (0.4), postmarginal vein very short (0.02), stigmal vein (0.1) one-fourth the marginal vein, marginal fringe short.

Hind wings (Fig. 6): Hyaline; acute at apex, less than six times as long as wide (1.1:0.2); marginal fringe at posterior margin long, one half width of wing at hamuli.

Forelegs (Fig. 7): Yellowish except coxae, trochanter and femora infuscated; tibial spur short, apical rim of tibiae with four small pegs; basitarsus, second and third tarsal segments with two pegs on each.

Middle legs (Fig. 8): Uniformly yellowish, tibial spur long, more than half the length of basitarsus; apical rim of tibiae with five distinct pegs.

Hind legs (Fig. 9): Uniformly yellowish except coxae slighly infuscated at basal tip; tibial spur a trifle more than half the length of basal tarsus; apical rim of tibiae with four distinct pegs.

Abdomen: Reddish brown with very faint iridescent blue lustre; as long as head and thorax together; ovipositor arising from apical one-third of abdominal venter; third valvulae (Fig. 10) moderate in size, lanceolate, less than seven times as long as wide, less than one-third the length of second valvifers (Fig. 10), outer plates of ovipositor (Fig. 10) longer than second valvifers.

Holotype: Female, INDIA, U.P. – Nainital, Pantnagar, ex. Agromyzid leaf mine (unidentified) on wild plant, 7 August, 1987 (M. A. Khan).

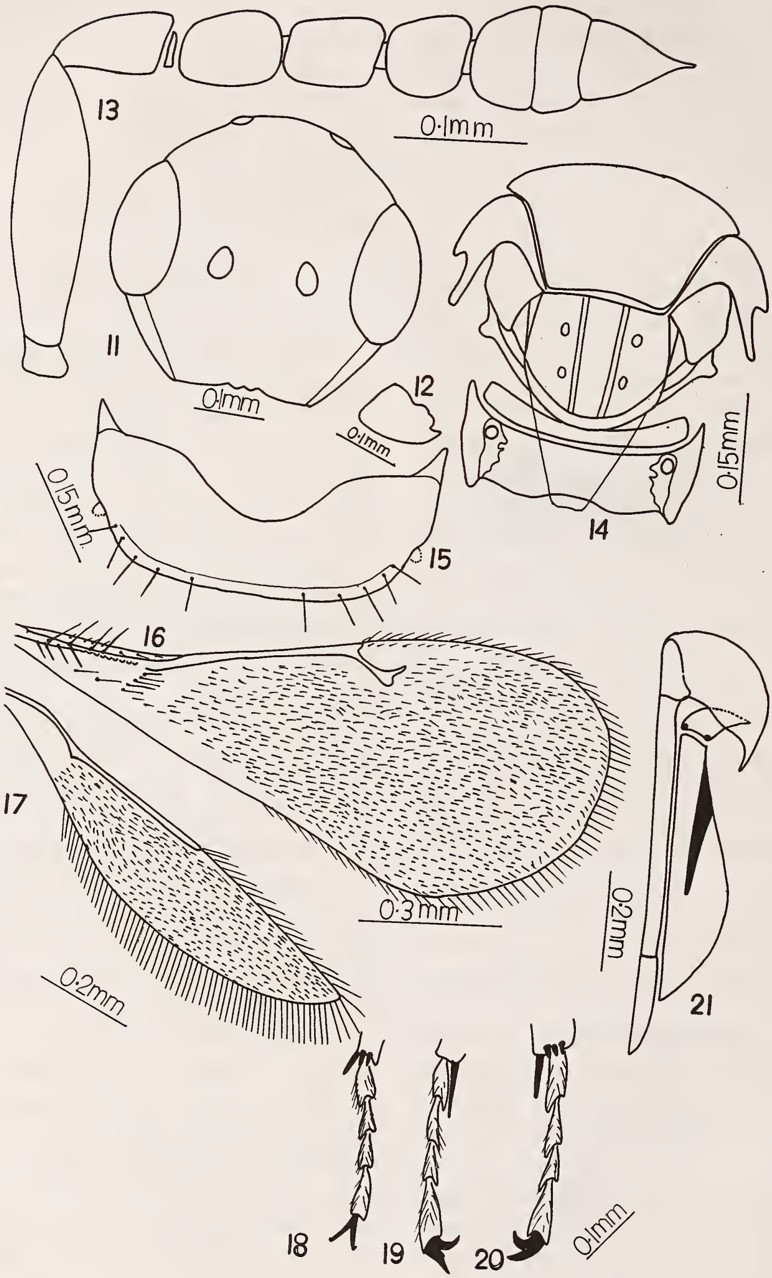
Paratype: Five females, same data as holotype.

Tetrastichus mangifera sp. nov.
(Figs. 11-21)

Head (Fig. 11): Dark with lower half of frontovertex, clypeus and malar space light yellowish, roundish, slightly wider than long in facial view (0.46:0.41); frontovertex much wider, more than one-half the total head width (0.26:0.46), ocelli dark, arranged in obtuse triangle; postocellar line slightly longer than ocellocular; eyes dark and smooth, antennae inserted well above the lower level of eyes; prominence between antennal sockets less than one-third the width of frons between eyes (0.1:0.26); malar space distinctly longer than eye width (0.14:0.09); malar suture distinct; lower margin of clypeus with two dents medially; mandibles tridentate (Fig. 12) maxillary and labial palpi each 1-segmented.

Antennae (Fig. 13): Dark except pedicel and scape yellowish with infuscations; 8-segmented excluding one ring segment; scape less than four times as long as wide (0.22:0.06); almost as long as three funicle segments together; pedicel less than twice as long as wide (0.09:0.05), distinctly longer than first funicle segment; funicle 3-segmented, segments 1-3 gradually decreasing in length distad; first funicle segment longer than wide (0.08:0.06); longer than second segment (0.07:0.06), third as long as wide (0.065:0.065); club 3-segmented, more than twice as long as wide (0.17:0.08), longer than preceding two funicle segments together.

Thorax (Fig. 14): Dark; non-iridescent; mesoscutum less than thrice as wide as long



Figs. 11-21. *Tetrastichus mangifera* sp. nov.
11. Head, facial view; 12. Mandible; 13. Antenna; 14. Thorax; 15. Pronotum; 16. Forewing; 17. Hind wing; 18. Part of foreleg; 19. Part of middle leg; 20. Part of hind leg; 21. Ovipositor.

(0.07:0.17), mesopraescutum twice as wide as long (0.34:0.17), with a row of five bristles at each lateral margin; scutellum wider than long with two submedian grooves and two pairs of setae with longitudinal striations; posterior margin rounded; mesopostphragma reaching beyond the propodeum; propodeum with strong mesal and paraspiracular carinae, spiracle almost touching the anterior margin of propodeum.

Forewings (Fig. 16): Hyaline; more than twice as long as wide (1.22:0.51); apex broadly rounded; costal cell with four setae, shorter than marginal vein; basal vein with five setae, basal area with two setae; cubital vein straight; speculum narrow, closed below; submarginal vein with four strong setae directed apically and four setae directed backwards; shorter (0.32) than marginal vein (0.35); postmarginal vein rudimentary; stigmal vein short (0.1); marginal fringe short.

Hind wings (Fig. 17): Hyaline, almost six times as long as wide, acute at apex; marginal fringe long.

Forelegs (Fig. 18): Uniformly yellowish except last tarsal segment infuscated; tibial spur short, apical rim of tibiae with three pegs.

Middle legs (Fig. 19): Uniformly yellowish except coxae and last tarsal segment infuscated; tibial spur longer than basitarsus; apical rim of tibiae with three pegs.

Hind legs (Fig. 20): Uniformly honey yellowish except coxae with a black spot on dorsal side and pretarsus with apical end infuscated; coxae, femora and tibiae compressed; tibial spur shorter than basitarsus, apical rim of tibiae with two pegs.

Abdomen (Fig. 21): Dark except basal one-third which is yellow; longer than thorax; ovipositor concealed, arising from base of abdominal venter; first valvifers semicircular (Fig. 21); second valvifers long and narrow, more or less of uniform width; anterior margin of basal part typically very large and much curved (Fig. 21), U-shaped; third valvulae almost four times as long as wide; more than one-third the second valvifers (Fig. 21), outer plates of ovipositor distinctly shorter than second valvifers.

Length of female: 1.12 mm.

Holotype: Female, INDIA, U. P. – Nainital, Pantnagar, ex. Coccids (unidentified) on *Mangifera indica*, 10 August , 1987 (M.A. Khan).

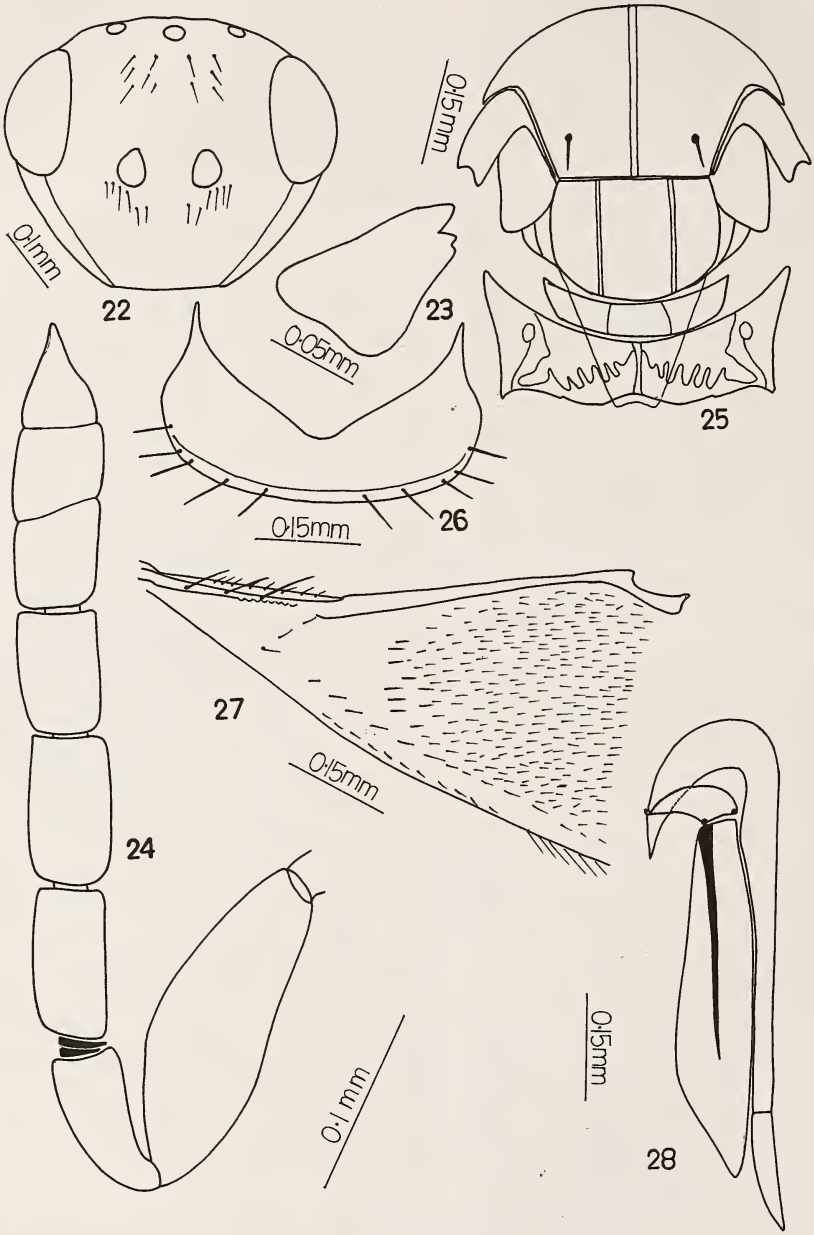
Paratype: Two females, same data as holotype.

Tetrastichus obliqua sp. nov.
(Figs. 22-28)

Head (Fig. 22): Completely yellowish brown; setose, setae dark brown, arranged in two rows at frons and a single row just below antennal sockets; wider than long (0.48:0.4); frontovertex wide, more than one-half the total head width (0.28:0.48); ocelli red, arranged in obtuse triangle, postocellar line one and a half times as long as ocellocular; eyes black and smooth; antennae inserted at lower level of eyes; prominence between antennal sockets distinctly more than one-fourth the width of frons between eyes (0.06:0.28); malar space very long, almost twice the eye width (0.19:0.1); malar suture distinct; lower margin of clypeus without dents medially; mandibles (Fig. 23) tridentate; maxillary and labial palpi each 1-segmented.

Antennae (Fig. 24): Uniformly yellowish, densely setose; 8-segmented excluding two ring segments; scape flattened, less than thrice as long as wide (0.16:0.06); pedicel long, twice as long as wide (0.08:0.04), as long as first funicle segment; first segment twice as long as wide (0.08:0.04), second segment as long as first but less than twice as long as wide (0.08:0.45), third short, less than one and a half times as long as wide (0.06:0.045); club 3-segmented, more than thrice as long as wide (0.14:0.45), slightly longer than preceding two funicle segments together.

Thorax (Fig. 25): Brown with reddish yellow admixture; pronotum (Fig. 26) with posterior submarginal ridge bearing five pairs of setae, antero-lateral arms slightly long and narrow; mesoscutum more than twice as wide as



Figs. 22-28. *Tetrastichus obliqua* sp. nov.
22. Head, facial view; 23. Mandible; 24. Antenna; 25. Thorax; 26. Pronotum; 27. Forewing (part); 28. Ovipositor.

long (0.52:0.24), mesopraescutum bearing a single seta at each lateral margin, middle longitudinal groove present; scutellum shorter than mesoscutum, more than twice as long as wide (0.38:0.18), with two submedian grooves and two pairs of setae; surface of propodeum smooth; median, paraspiracular and oblique carinae present, mesal length of propodeum less than one-third length of scutellum, propodeal spiracles separated from anterior margin by a space more than one-half as great as length of a spiracle; mesopostphragma reaching well beyond the propodeum.

Forewings (Fig. 27): Hyaline; venation very light yellow; more than twice as long as wide (1.2:0.52), costal cell narrow with eight small setae; basal vein with three setae; basal cell bare; speculum of moderate size, open below; submarginal vein (0.26) with three strong setae, less than twice the length of marginal vein (0.44); postmarginal vein absent; stigmal vein short, almost one-fifth the length of marginal vein.

Legs: Yellow except fore coxae brown, middle tibial spur distinctly shorter than basitarsus.

Abdomen (Fig. 28): Brown with yellowish reflections; longer than head and thorax together; ovipositor exserted; first valvifers (Fig. 28) semicircular; anterior margin of basal part of second valvifers much curved and U-shaped (Fig. 28); third valvulae less than six times as long as wide, slightly more than one-third the length of second valvifers (Fig. 28); outer plates of ovipositor (Fig. 28) distinctly shorter than second valvifers.

Length of female: 1.24 mm.

Holotype: Female, INDIA, U.P. – Nainital, Pantnagar, ex. pupa of *Spilosoma obliqua* (Lepidoptera: Arctidae) on *Glycine max*, 10 October, 1987 (M. A. Khan).

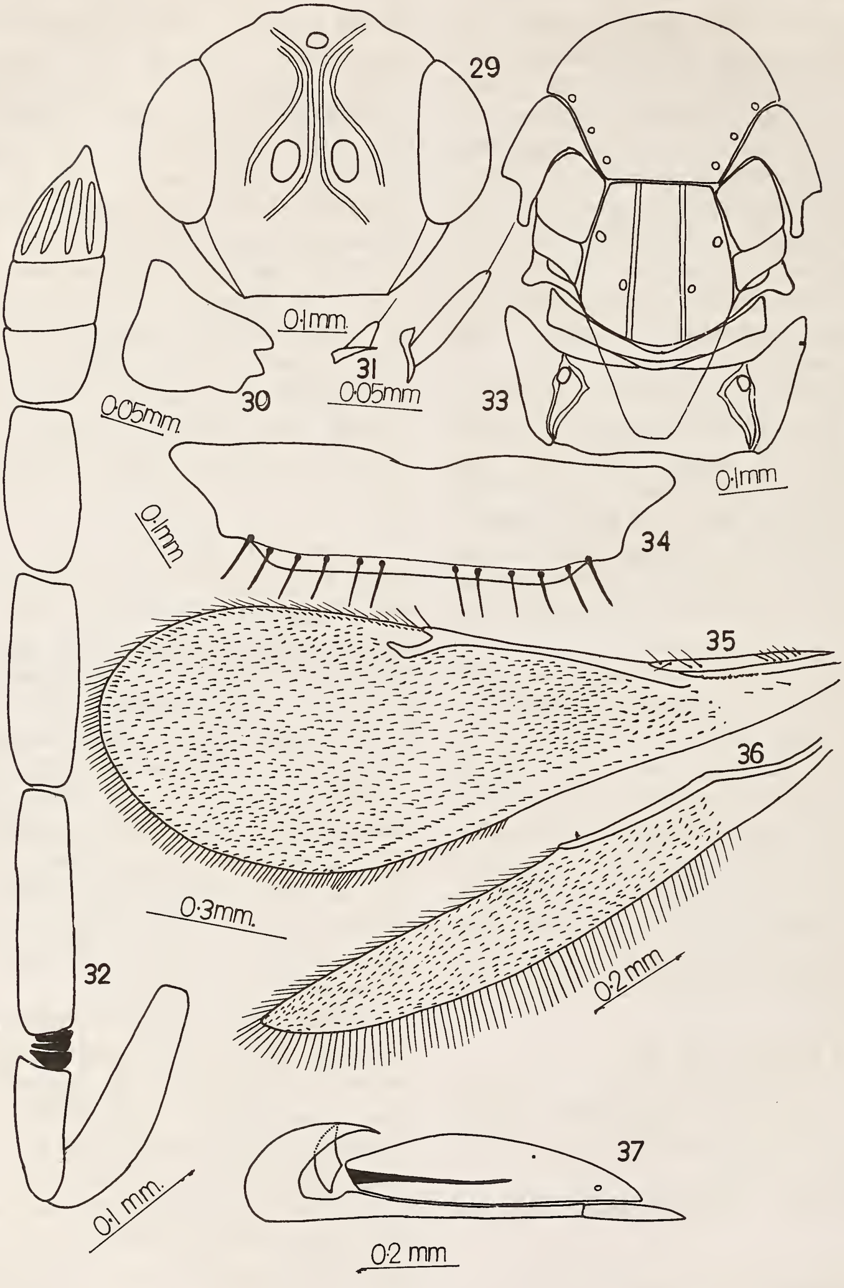
Paratype: Six females, same data as holotype.

Tetrastichus chakrataensis sp. nov.
(Figs. 29-37)

Head (Fig. 29): Dark brown with strong iridescent bluish lustre; area of frons dorsad and laterad of scrobe cavity deeply punctured, area immediately ventrad of antennae bases shagreened; fracture at ventral margin of compound eye obscure, small, wider than long in facial view (0.52:0.43); frontovertex width distinctly more than one-half the total head width (0.3:0.52), ocelli reddish, arranged in obtuse triangle, postocellar line more than as long as ocellocular; eyes bare, antennae inserted almost at the middle, prominence between antennal sockets less than one-seventh the width of frons between eyes (0.045:0.03); malar space longer than eye width (0.12:0.1); malar suture distinct; lower margin of clypeus without dents medially; mandibles (Fig. 30) tridentate, maxillary and labial palpi each 1-segmented (Fig. 31).

Antennae (Fig. 32): Brown except club white, scape whitish with infuscation on dorsal side, 8-segmented excluding three ring segments; scape cylindrical, more than four times as long as wide (0.17:0.04), pedicel two and a half times as long as wide (0.1:0.4); more than half the length of first funicle segment; funicle 3-segmented, segments gradually decreasing in length and increasing in width distad; first funicle segment more than four times as long as wide (0.164:0.04), second less than thrice as long as wide (0.14:0.05) third twice as long as wide (0.12:0.06); club 3-segmented, less than thrice as long as wide (0.18:0.07), longer than preceding funicle segment.

Thorax (Fig. 33): Dark brown with strong iridescent bluish lustre; pronotum (Fig. 34) with posterior submarginal ridge bearing six pairs of setae, antero-lateral angles obtuse and laterally directed; mesoscutum less than twice as wide as long (0.46:0.25), mesopraescutum bearing one row of bristles at each lateral margin; scutellum longer than wide (0.25:0.2), with two submedian longitudinal grooves and two pairs of setae, posterior margin rounded; mesopostphragma not reaching beyond the propodeum, surface of propodeum shagreened, strong mesal and



Figs. 29-37. *Tetrastichus chakrataensis* sp. nov.
29. Head, facial view; 30. Mandible; 31. Maxillary and labial palpi; 32. Antenna; 33. Thorax; 34. Pronotum; 35. Forewing; 36. Hind wing; 37. Ovipositor.

paraspiracular carinae present, propodeal spiracles separated from anterior margin by a space one-half as great as length of a spiracle.

Forewings (Fig. 35): Hyaline, less than thrice as long as wide (1.46:0.53); disc densely setose; costal cell short and narrow, with a row of six small setae at basal half and four long setae at apical end; basal vein with four setae; basal cell setose; cubital vein straight, speculum absent; submarginal vein with two long setae, much shorter (0.38) than marginal vein (0.45), postmarginal vein very short (0.02), stigmal vein (0.11) more than one-fourth the length of marginal vein; marginal fringe short.

Hind wings (Fig. 36): Hyaline, less than seven times as long as wide (1.24:0.19), densely setose; marginal fringe long.

Legs: Uniformly yellow except coxae brown and tarsal segments 3-4 infuscated, middle and hind tibial spur shorter than respective basitarsus.

Abdomen: Brownish with metallic reflections; longer than thorax; ovipositor arising from basal one-third of abdominal venter; first valvifers semicircular; anterior margin of basal part of second valvifers much curved (Fig. 37); third valvulae less than six times as long as wide, more than one-third the length of second valvifers; outer plate of ovipositor (Fig. 37) distinctly shorter than second valvifers, submarginal plate (Fig. 37) broad, posterior margin with a notch in the middle.

Length of female: 1.41 mm.

Holotype: Female, INDIA, U.P. – Chakrata (2745 m), ex. Lepidopterous leafmine (unidentified) on wild plant, 4 May, 1986 (M. A. Khan).

Paratype: Two females, same data as holotype.

Tetrastichus partellus sp. nov.
(Figs. 38-48)

Head (Fig. 38): Dark brown with varying degree of metallic green; iridescent; wider than long (0.58:0.47), frontovertex much wider, distinctly more than one-half the total head width (0.34:0.58), antennae inserted just above the line drawn across lower level of eyes; prominence between antennal sockets more than one-fifth the width of frons between eyes (0.06:0.34); subocular suture distinct, mandibles bidentate (Fig. 39) with an acute tooth and truncation.

Antennae (Fig. 41): Uniformly dark brown with scape and pedicel white, 8-segmented excluding one ring segment; scape cylindrical, less than five times as long as wide (0.21:0.045); pedicel distinctly less than twice as long as wide (0.07:0.45), shorter than first funicle segment; first funicle segment longer than wide (0.08:0.065), second segment shortest, a trifle longer than wide (0.07:0.065), third segment longest, distinctly longer than wide (0.09:0.065), club 3-segmented, more than thrice as long as wide (0.23:0.07), a trifle shorter than funicle segments 1-3 together; funicle segment 1 to last club segments with 5, 4, 5, 6 and 3 sensoria respectively.

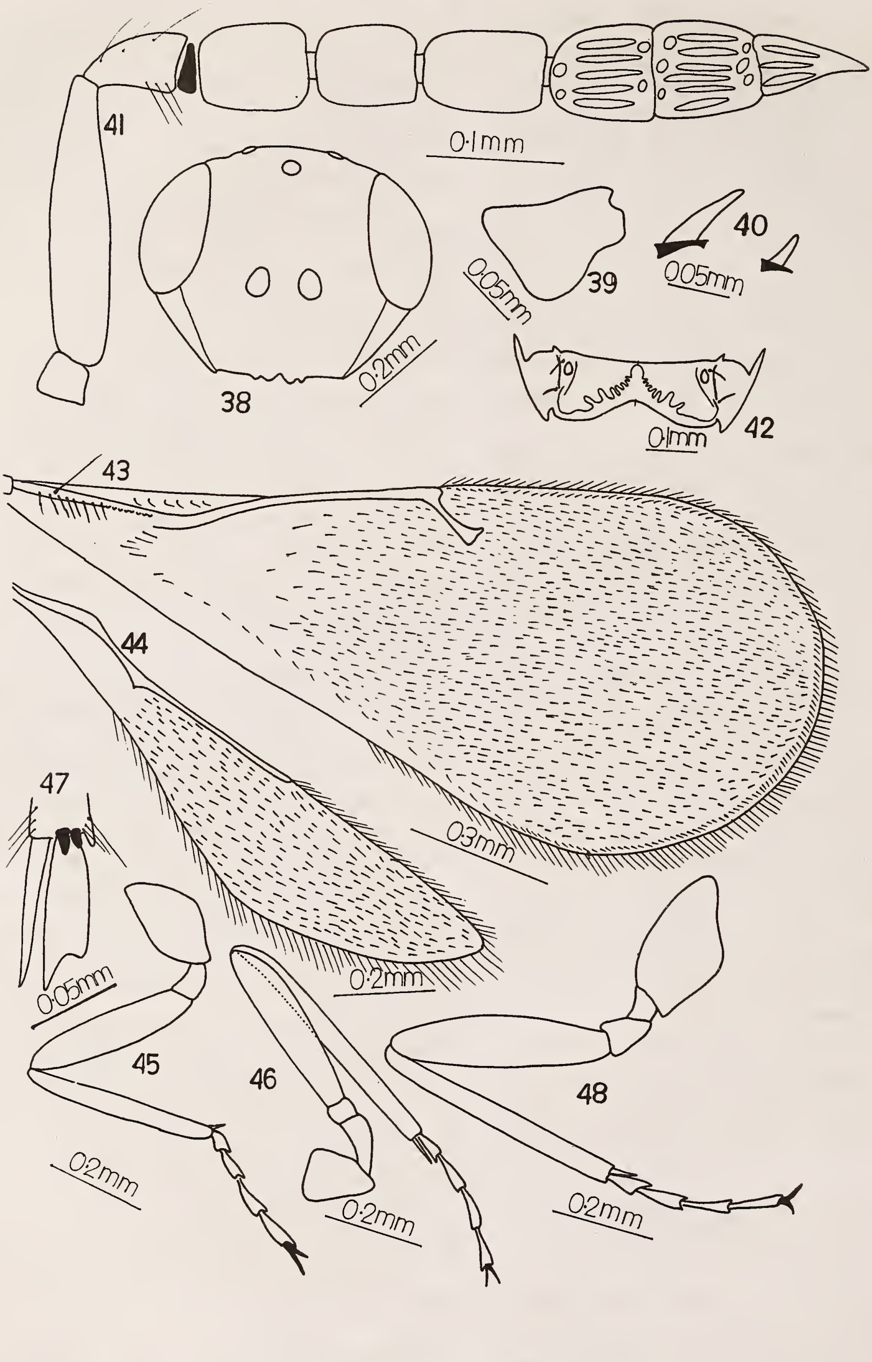
Thorax: Dark brown with metallic green iridescence; surface of propodeum (Fig. 42) reticulate, median paraspiracular and oblique carinae present, mesal length of propodeum one-third length of scutellum; propodeal spiracle separated from anterior margin by a space almost as great as length of a spiracle.

Forewings: (Fig. 43): Hyaline, venation dark brown; more than twice as long as wide; costal cell broad, with six setae arranged in a row; submarginal vein with a long seta directed upwards and setae in a row directed downwards; submarginal vein (0.46) longer than marginal vein (0.38); postmarginal vein rudimentary; stigmal vein (0.1) almost one-fourth the marginal vein; marginal fringe long, spaced by a distance equal to almost one-fourth length of a fringe.

Hind wings (Fig. 44): Hyaline, blunt at apex; more than four times as long as wide.

Forelegs (Fig. 45): Uniformly dark brown except tibiae tan; tarsal segments 1-4 light brown.

Middle legs (Fig. 46): Uniformly dark brown except tibiae at apical one-third and first



Figs. 38-48. *Tetrastichus partellus* sp. nov.
38. Head, facial view; 39. Mandible; 40. Maxillary and labial palpi; 41. Antenna; 42. Propodeum; 43. Forewing; 44. Hind wing; 45. Foreleg; 46. Middle leg; 47. Part of middle leg; 48. Hind leg.

tarsal segment yellowish, tarsal segments 2-4 light brown, tibial spur long, as long as basitarsus, apical rim of tibiae (Fig. 47) with two stout pegs.

Hind legs (Fig. 48): Colouration same as that of middle legs.

Abdomen: Dark brown with metallic green iridescence; shorter than thorax; ovipositor almost concealed.

Length of female: 1.42 mm.

Holotype: Female, INDIA, U.P. – Nainital, Pantanagar, ex. Pupae of *Chilo partellus* (Lepidoptera: Crambidae) on *Zea mays,* 20 October, 1987 (M. A. Khan).

Paratype: Two females, same data as holotype.

Tetrastichus pyrillae Crawford
(Figs. 49-54)

Head (Fig. 49): Dark brown with yellowish reflections on frons; wider than long in facial view (0.56:0.48); frontovertex much wider, more than one-half the total head width (0.3:0.56); ocelli white, arranged in obtuse triangle, postocellar line almost one and one-half times as long as ocellocular; areas of frons laterad and dorsad of scrobe cavity with well marked transverse reticulations; eyes dark and smooth; antennae inserted well above lower level of eyes; prominence between antennal sockets one-fifth the width of frons between eyes (0.06:0.3); malar space longer than eye width (0.18:0.13); malar suture absent; lower margin of clypeus without dents medially; mandibles bidentate (Fig. 49) with acute teeth; maxillary and labial palpi each 1-segmented.

Antennae (Fig. 50): Dark brown except scape infuscated; 8-segmented excluding one ring segment; scape cylindrical, more than four times as long as wide (0.22:0.05); pedicel distinctly less than twice as long as wide (0.08:0.05); funicle 3-segmented; first funicle segment almost twice as long as wide (0.12:0.065), second distinctly less than twice as long as wide (0.11:0.065), third segment less than one and a half times as long as wide (0.115:0.08), distinctly wider than second segment; club 3-segmented, more than twice as long as wide (0.22:0.09), shorter than preceding two funicle segments together.

Thorax (Fig. 51): Dark brown; pronotum (Fig. 52) with posterior submarginal ridge bearing six pairs of setae, antero-lateral angles obtuse and laterally directed; mesoscutum more than two times wider than long (0.48:0.23); mesopraescutum bearing one row of five setae at each lateral margin; scutellum wider than long (0.25:0.22), shorter than mesoscutum; propodeum shagreened, lateral carinae present.

Forewings (Fig. 53): Hyaline; venation infuscated, more than twice as long as wide (1.4:0.68); costal cell narrow, bare; basal vein with five setae; basal cell bare, open; speculum moderate, closed below; cubital vein straight; subcubital line of hairs short, starting from one-third the distance from base; submarginal vein (0.38) with a single seta, as long as marginal vein (0.38); postmarginal vein rudimentary; stigmal vein (0.13) almost one-third the length of marginal vein; marginal fringe short.

Hind wings: Hyaline, less than six times as long as wide; marginal fringe long.

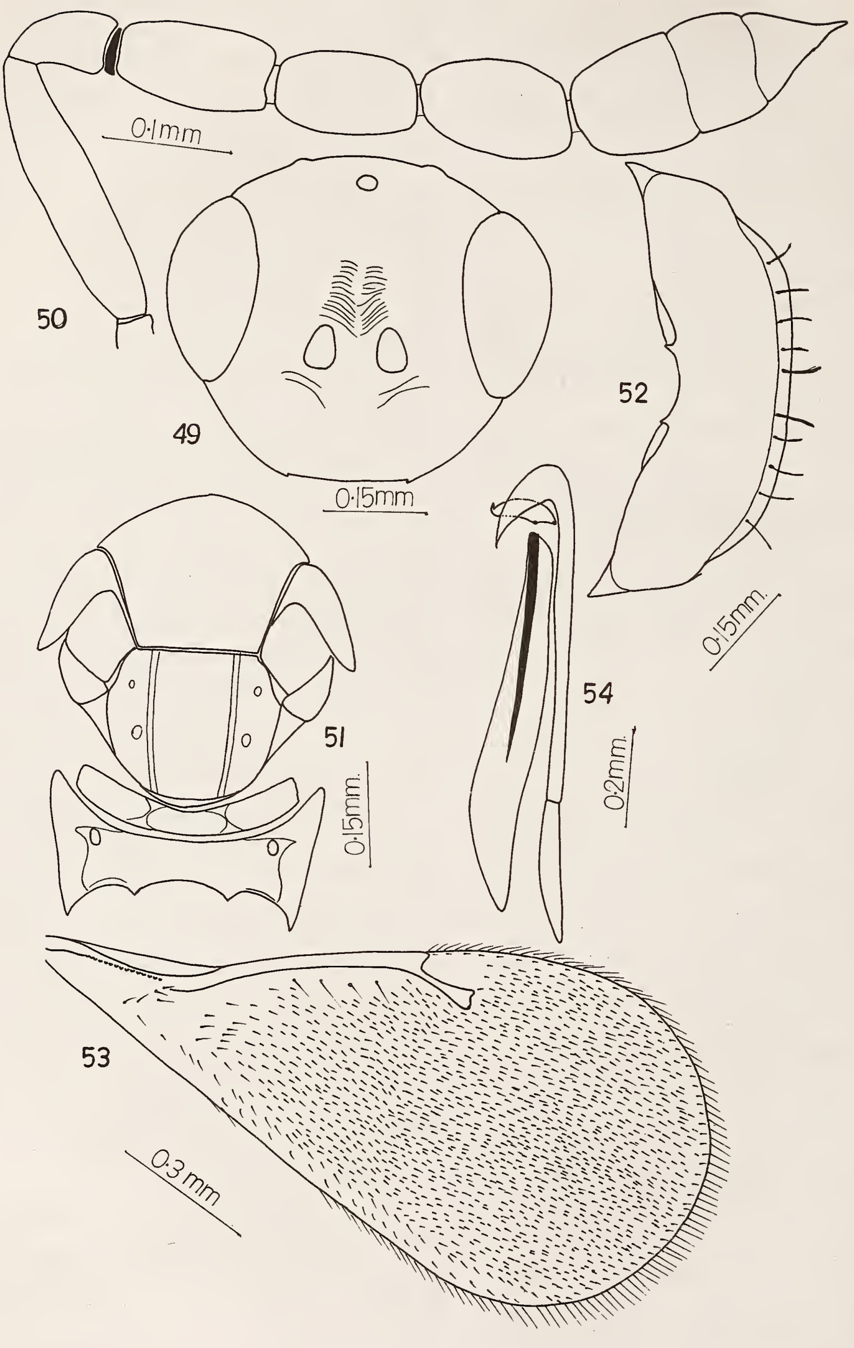
Legs: Dark brown except apex of femora, tibiae and tarsal segments 1-4 yellowish.

Abdomen: Dark brown with metallic reflections; longer than thorax; ovipositor arising from base of abdominal venter; third valvulae (Fig. 54) long, almost seven times as long as wide, distinctly less than one-third the length of second valvifers (Fig. 54); outer plates of ovipositor (Fig. 54) longer than second valvifers.

Length of female: 1.42 mm.

Male: Not known.

Material examined: Six females, INDIA, U.P. – Nainital, Pantnagar, ex. eggs of *Pyrilla perpusilla* on sugarcane, 20 August, 1987 (S. N. Sushil).



Figs. 49-54. *Tetrastichus pyrillae* Crawford
49. Head, facial view; 50. Antenna; 51. Thorax; 52. Pronotum; 53. Forewing; 54. Ovipositor.

Tetrastichus lotellae Delucchi
(Figs. 55-63)

Head (Fig. 55): Yellowish brown; wider than long in facial view (0.48:0.41); frontovertex less than one-half the total head width (0.23:0.48); ocelli red, arranged in obtuse triangle, post ocellar line greater than ocellocular; eyes black, smooth; prominence between antennal sockets more than one-fourth the width of frons between eyes (0.055:0.23); malar space longer than eye width (0.13:0.12); antennae inserted well above the lower level of eyes; malar suture distinct; lower margin of clypeus without dents medially; mandibles tridentate (Fig. 56); maxillary and labial palpi each 1-segmented (Fig. 57).

Antennae (Fig. 58): Uniformly yellowish with infuscation; 8-segmented excluding two ring segments; scape cylindrical, more than four times as long as wide (0.21:0.05); pedicel twice as long as wide (0.08:0.04), as long as first funicle segment; funicle 3-segmented; first funicle segment a trifle less than twice as long as wide (0.08:0.045), second longer than first segment, less than twice as long as wide (0.09:0.051), third segment short, less than one and a half times as long as wide (0.07:0.05); club 3-segmented, more than thrice as long as wide (0.019:0.06), longer than preceding two funicle segments together.

Thorax (Fig. 59): Light brown with golden reflections on dorsum; pronotum (Fig. 60) with posterior margin slightly concave with seven pairs of setae, anterior margin concave in the middle; mesoscutum slightly less than two and a half times as long as wide (0.52:0.2); mesopraescutum with a single row of three bristles at each lateral margin, median furrow present; scutellum shorter than mesoscutum, with two submedian grooves and two pairs of setae; posterior margin rounded; mesopostphragma well developed, reaching beyond the propodeum, propodeum short, mesal length of propodeum almost one-third that of scutellum, median carina wanting, spiracles large, almost contiguous with the anterior margin.

Forewings (Fig. 61): Hyaline, densely setose; more than twice as long as wide (1.18:0.51); costal cell broad, with 11 setae on the margin, basal vein with five setae; basal cell bare; speculum short and closed below; cubital vein straight; submarginal vein (0.34) with four setae, a trifle shorter than marginal vein (0.35); postmarginal vein (0.02) distinct; stigmal vein (0.13) less than one-third the length of marginal vein; fringe short, spaced by a distance equal to one-fourth their length.

Hind wings (Fig. 62): Hyaline, more than four times as long as wide (1.0:0.23) with blunt apex; marginal fringe almost one-third the wing width, spaced by a distance equal to one-sixth their length.

Legs: Yellow except coxae, margins of femora and pretarsus brown, hind coxae infuscated, middle tibial spur slightly shorter than basitarsus.

Abdomen: Light brown with a yellow patch in the middle of dorsum; as long as head and thorax together, ovipositor exserted; first valvifers (Fig. 63) semicircular; third valvulae (Fig. 63) very long, lanceolate, more than 10 times as long as wide, distinctly less than one-third the length of second valvifers (Fig. 63); outer plates of ovipositor (Fig. 63) almost as long as second valvifers.

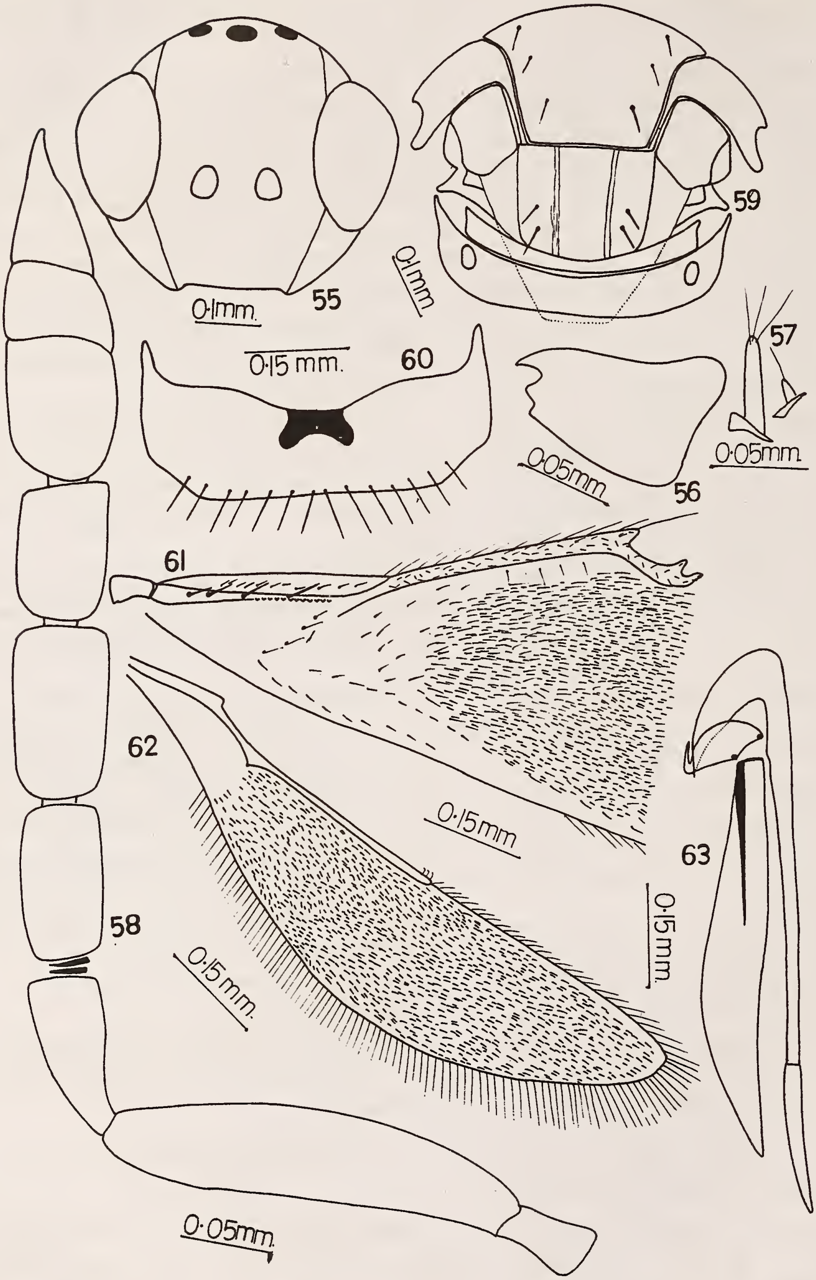
Length of female: 1.13 mm.

Male: Not known.

Material examined: Three females, INDIA, U.P. – Pantnagar, host not known, 9 July, 1988 (S.N. Sushil).

Tetrastichus misellus Delucchi
(Figs. 64-74)

Head (Fig. 64): Yellowish except dorsum which is brown, wider than long in facial view (0.56:0.47); frontovertex much wider, more than one-half the total head width (0.34:0.56); ocelli red, arranged in obtuse triangle, length of pos-



Figs. 55-63. *Tetrastichus lotellae* Delucchi
55. Head, facial view; 56. Mandible; 57. Maxillary and labial palpi; 58. Antenna; 59. Thorax; 60. Pronotum; 61. Forewing (part); 62. Hind wing; 63. Ovipositor.

tocellar line more than twice as great as ocellocular; eyes dark, smooth; antennae inserted well above the lower level of eyes; prominence between antennal sockets less than one-sixth the width of frons between eyes (0.06:0.34); malar space longer than eye width (0.15:0.11); malar suture distinct; lower margin of clypeus without dents medially; mandibles (Fig. 65) tridentate with acute teeth; maxillary and labial palpi each 1-segmented.

Antennae (Fig. 66): Brown except scape and apical tip of pedicel yellowish; scape cylindrical, more than five times as long as wide (0.28:0.05); pedicel more than twice as long as wide (0.05:0.04), distinctly less than half the length of first funicle segment; two ring segments present; funicle 3-segmented; first funicle segment very long, more than five times as long as wide (0.22:0.04), second (18:0.05) slightly longer than third funicle segment (0.17:0.05); club 3-segmented, less than five times as long as wide (0.25:0.55), distinctly shorter than preceding two funicle to last club segment with 7, 9, 9, 4, 6 and 5 sensoria respectively.

Thorax (Fig. 67): Brown with fine reticulate sculpture; pronotum (Fig. 68) with posterior margin slightly concave, with five pairs of setae; mesoscutum more than twice as wide as long (0.05:0.21), without middle longitudinal groove, mesopraescutum with eight pairs of setae arranged in two rather irregular rows at each lateral margin; each parapside with two setae; scutellum longer than wide (0.28:0.22), longer than mesoscutum, with two submedian grooves and two pairs of setae; metanotum band-like; propodeum with reticulate sculpture, mesal length of propodeum less than half the length of scutellum, propodeal spiracles separated from anterior margin by a space almost the length of a spiracle, strong mesal and paraspiracular carinae present and a series of short carinae radiating latero-anteriorad from posterior margin; mesopostphragma not reaching beyond the propodeum; rudimentary petiole narrow.

Forewings (Fig. 69): Hyaline, almost thrice as long as wide (1.8:0.61); densely setose; costal cell narrow, more than half the length of marginal vein (0.43:0.64), with eight setae arranged in a row; basal vein with three setae; basal cell bare; speculum large and open below; cubital vein straight; submarginal vein (0.41) with five setae; marginal vein very long (0.64), more than one and a half times the length of submarginal vein; postmarginal vein rudimentary; stigmal vein very short (0.07); five admarginal hairs present; marginal fringe short, spaced by a distance almost one-fourth length of a fringe.

Hind wings (Fig. 70): Hyaline, less than four times as long as wide; marginal fringe short.

Forelegs (Fig. 71): Uniformly yellowish except slight infuscation on apex, tibial spur short.

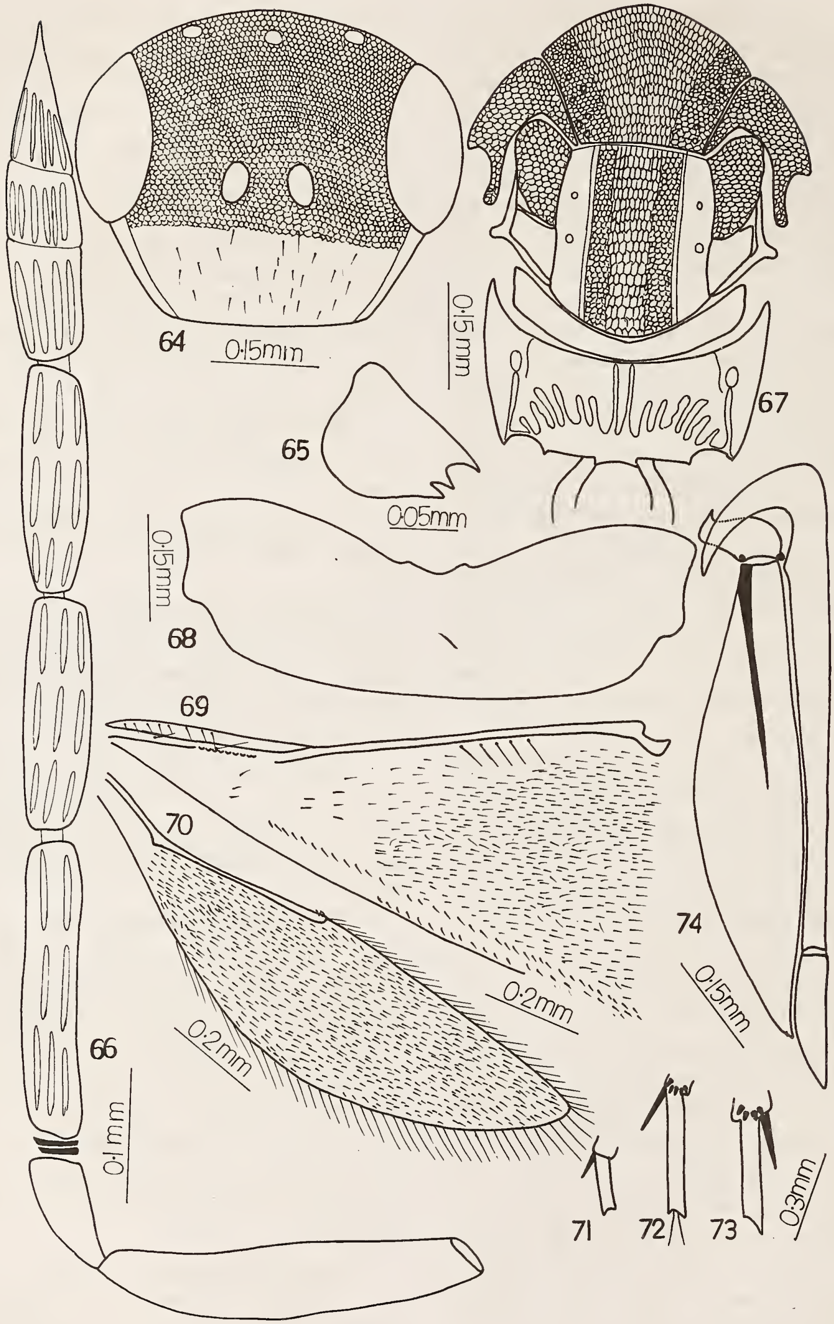
Middle legs (Fig. 72): Uniformly yellowish except coxa on greater part, third and fourth tarsal segments brown; apical rim of tibiae with five pegs; tibial spur short, less than half the length of basitarsus.

Hind legs (Fig. 73): Yellowish except coxae brown, last two tarsal segments infuscated; tibial spur more than half the length of basitarsus; apical rim of tibiae with four distinct pegs.

Abdomen: Brownish with golden reflections on dorsum; surface smooth; ovipositor slightly exserted, arising from basal one-third of abdominal venter; first valvifers (Fig. 74) semicircular, with articular knobs prominent; third valvulae (Fig. 74) five times as long as wide, less than one-fourth the length of second valvifers (Fig. 74); outer plates of ovipositor (Fig. 74) as long as second valvifers; subgenital plate broad (Fig. 74), posterior margin with a notch in the middle.

Length of female: 1.3 mm.

Material examined: Eleven females, INDIA, U.P. – Nainital, Pantnagar, host not known, 19 August, 1987 (S. N. Sushil).



Figs. 64-74. *Tetrastichus misellus* Delucchi
64. Head, facial view; 65. Mandible; 66. Antenna; 67. Thorax; 68. Pronotum; 69. Forewing (part); 70. Hind wing; 71. Part of foreleg; 72. Part of middle leg; 73. Part of hind leg; 74. Ovipositor.

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ON THE TAXONOMIC STATUS OF CERTAIN SPECIES OF *PAVETTA* (RUBIACEAE) FROM THE INDIAN SUBCONTINENT[1]

D. B. Deb and R. C. Rout[2]

The genus *Pavetta* L. (Rubiaceae) is represented by about 400 species in the Old World. It was intensively studied by Bremekamp (1934, 1939 a,b). He described 42 species and nine varieties from the Indian subcontinent, including 29 species and eight varieties as new. He, however, distinguished species sometimes on the basis of one or two quantitative characters. Very often a slight difference in length of the calyx teeth or hairiness of the leaf or corolla tube were sufficient for him to distinguish species. He also did not hesitate to postulate species on the basis of very incomplete or insufficient material bearing no flower or fruit. Due to unsatisfactory delimitation of taxa, Bridson (1978) and Kok and Grobbelaar (1984) synonimised a number of species.

We have been working on the taxonomy of the genus *Pavetta* in the Indian subcontinent, and are convinced that some taxa do not deserve the status given. These are presented below with their synonymy.

(1) *Pavetta gleniei* Hook. f. (1880: 152-153) was postulated on the basis of *Thwaites, C. P.* 2815 and *Walker* 14 from Sri Lanka. Bremekamp (1934) segregated *Walker* 14 and a part of *Thwaites, C.P.* 2815 to describe *P. malacophylla* Bremek., distinguishing it from the former species by the shorter calyx lobes, leaves beneath tomentose and midrib not prominent beneath. He further recognized in *P. gleniei* two varieties on the basis of hairiness of leaves, inflorescence and ovary. A study of the protologues along with the type specimens and other recent collections (which were not examined by Bremekamp) shows that *P. gleniei* varies in hairiness, length of calyx teeth (to some extent) as well as in shape and colour of leaves, and these variations are continuous. Calyx teeth are 2.5-5.0 mm long, leaves are broadly elliptic to elliptic-lanceolate and brownish to black when dry. Corolla is similar in both species though Bremekamp appears to have overlooked examining it in *Thwaites, C.P.* 2815 a & b (K!) bearing one flower each. The inflorescence is densely pubescent or tomentose. The midrib is not "non prominente" in *P. malacophylla* as described by Bremekamp. Thus these are not taxonomically distinguishable and are synonymous as follows.

Pavetta gleniei Hook.f. Fl. Brit. Ind. 3: 152. 1880 (type: Sri Lanka, *Thwaites, C.P.* 2815 a holo. K!, iso. CAL!); Trimen, Hort. Zeyl. 43. 1888 & Fl. Ceyl. 2: 350.1894; Bremek. in Fedde Repert. 37: 80.1934.

P. gleniei Hook. f. var. *glabrescens* Bremek. (=var. *gleniei*) l.c. 81. (Type: *Thwaites C.P.* 2815a, holo. K!, photo CAL!), *nom surperfl.*

P. gleniei Hook.f. var. *pubescens* Bremek. l.c. 81 (Type: *Thwaites, C.P.* 2815 b, holo. K!, photo CAL!) syn. nov.

P. malacophylla Bremek. l.c. 81 (Type: *Thwaites, C. P.* 2815 c, holo. K!, photo CAL!) syn. nov.

P. tomentosa Thw. Enum. Pl. Zeyl. 156. 1859, non Roxb. ex Smith, 1819.

Ixora gleniei (Hook.f.) Kuntze, Rev. Gen. Pl. 1: 286. 1891.

(2) In the subgen. 2 *Eupavetta* (=*Pavetta*) sect. *Pavettaster,* ser. 2 *Angustistipulae,* Bremekamp (1934: 81-82) described three species: *Pavetta travancorica, P. concanica* and *P. laeta* on the basis of two gatherings each. These species were distinguished by the shape and venation of leaves and the length of corolla tube: leaves being lanceolate in *P. travancorica,* elliptic in *P. concanica* and *P. laeta*; lateral ner-

[1]Accepted November 1991.

[2]Betanical Survay of India, P. O. Botanic Garden, Howrah-711 103.

ves 10-12 pairs in *P. travancorica* and *P. concanica,* 6-9 pairs in *P. laeta* and corolla tube 6.5-8 mm in *P. travancorica* and *P. laeta,* 12-14 mm in *P. concanica.* A study of protologues and type specimens and other collections (not examined by Bremekamp) reveals that the leaves are variable from elliptic to elliptic-lanceolate or lanceolate with 8-12 pairs of lateral nerves; corolla tube is 6.5-12 mm long, depending partly on the varying stages of development. The form of stipules and their apices vary even on the same specimen. These variations evidently indicate that they are not taxonomically distinct, even as varieties. Accordingly the three species are reduced to one as follows.

Pavetta travancorica Bremek. in Fedde Repert. 37: 81. 1934 (Type: Travancore, June 1835, *R. Wight s.n.* (*Kew Distrib. No.* 1485, holo. K!, photo CAL!).

P. concanica Bremek. l.c. 81 (type: Concan, *Law s.n.,* holo. K!, photo CAL!) syn. nov.

P. laeta Bremek. l.c. 82 (type: Tamil Nadu, Pulney Hills, 1914, *R.A. Sauliere* 673, holo. K!, photo CAL!) syn. nov.

(3) *Pavetta stocksii* Bremek. (1934: 113) was described on the basis of three gatherings: *Cooke s.n., Tilak* 88 and *Stocks s.n.,* all extant at K. On describing this species the author stated "it is not impossible that this species and the last one (*P. crassicaulis*) are merely varieties of the same". A study of the protologues, the types as well as a paratype (*Tilak* 88 E!) shows that the hairiness on the underside of the leaf is variable, being softly to densely pubescent. Hence *P. stocksii* is reduced to a synonym as follows.

Pavetta crassicaulis Bremek. in Fedde Repert. 37: 112. 1934 & 47: 25. 1939 (type: Concan, *Stocks s.n.*, holo. K!, photo CAL!). *P. stocksii* Bremek. *l.c.* 113 (Type: loc.?, *Stocks s.n.* holo. K!, photo CAL!) syn. nov.

(4) *Pavetta birmahica* Bremek. (1934: 115) from Burma was distinguished into the varieties, namely var. *glabrescens* "folia supra glabrescentia" and var. *tomentosa* "folia utrimque tomentosa", the former being the typical variety. According to the International Code of Botanical Nomenclature, the typical variety does not require a different varietal name. It is var. *birmahica,* where leaves are sparsely to densely pubescent on the upper surface, thereby it comes closer to var. *tomentosa.* Examination of types and other specimens shows that hairiness is variable to such an extent that the varieties do not stand and deserve to be merged. *P. gamblei* Bremek. (l.c. 114) was based on a single specimen *Gamble* 115. It agrees with *P. birmahica* in all respects except the length of the corolla tube (8 mm), which in *P. birmahica* is up to 6 mm long. It is likely to be at an earlier stage of development. Moreover, a species cannot be distinguished on slightly longer corolla tube only. In consideration of these facts these are merged here as follows.

Pavetta birmahica Bremek. in Fedde Repert. 37: 115. 1934 (Type: Burma, Thayetungo dist., Minhea, 17. 12. 1904, *J.H. Lace* 2698, holo. K! iso. CAL!).

P. birmahica Bremek. var. *glabrescens* Bremek. l.c. (=var. *birmahica*).

P. birmahica Bremek. var. *tomentosa* Bremek. l.c. (type: Burma, *Griffith* 3010, holo. K!, iso. CAL!) syn. nov.

P. gamblei Bremek. l.c. 114 (Type: Burma, Irawaddi. Mejanoung, 4. 5. 1872, *J. S. Gamble* 115, holo. K!, photo CAL!) syn. nov.

(5) In describing *Pavetta indica* L., Hook.f. (1880) considered about 20 names involved and treated them under five varieties, viz. var. *indica proper (=indica),* var. *polyantha,* var. *tomentosa,* var. *montana,* and var. *minor.* Bremekamp (1934) upgraded them as species and further postulated *P. amabilis, P. assamica, P. bengalensis, P. griffithii, P. neglecta, P. polyneura, P. thomsonii* and *P. praecox* and few varieties therein, on the basis of specimens treated by Hooker f. (l.c.) under those varieties. From a critical study of the specimens involved along with new gatherings not examined by Hook.f. or Bremekamp, we are convinced that Hook.f.'s treatment of the first three varieties

and the var. *montana* treated by Bremekamp as a species (*P. blanda*) are justified. The last variety, var. *minor*, treated by Bremekamp as a variety under a different species (*P. thomsonii* Bremek. var. *puberula* Bremek.) deserves a specific status. The other new species described by Bremekamp do not stand and become synonyms under the varieties of Hook.f.

P. neglecta Bremek. and *P. amabilis* Bremek. (1934: 92, 100) agree with *P. indica* L. var. *polyantha* Hook f. with leaves narrowly obovate, oblanceolate or elliptic-lanceolate, acute or caudate at apex, acute at base, puberulous beneath or only on nerves, stipules ovate, cymes pubescent, flowers densely crowded. There is no difference in floral characters. The shape of leaves in *P. neglecta* described in the protologue as "rhomboidal" is actually found to be elliptic-lanceolate or obovate. In *P. amabilis*, the stipules described as "subquadrate cuspidate" are ovate cuspidate. *P. bengalensis* Bremek. and *P. polyneura* Bremek. (1934: 99, 120) agree with each other in all respects and differ from *P. indica* L. var. *polyantha* Hook.f. in leaves broadly obovate, pubescent on the nerves beneath. *P. griffithii* Bremek. (1934: 99) differs from it in leaves lanceolate, corolla tube pubescent at throat. *P. assamica* Bremek. (1934: 119) differs from the same in having small leaves, broadly elliptic with slender lateral nerves closely arranged. The leaf shape and hairiness are variable in this taxon. So, these differences are not taxonomically justified and these species do not deserve any infra specific status even and are synonymous with *P. indica* L. var. *polyantha* Hook.f.

P. praecox Bremek. (1934: 114) was based on a single gathering, *Ritchie* 352. It is characterised by small broadly elliptic (4x3 cm) leaves, obtuse at both ends. It agrees fully with *P. indica* L. var. *tomentosa* (Roxb. ex Sm.) Hook.f. where leaves are variable in size (4-26.5 x 1-12 cm), shape, hairiness etc. The apex may be acute, acuminate, subacute, obtuse or rounded. There is no difference in floral characters. So *P. praecox* does not stand as a distinct species. *P. indica* L. var. *mollis* Bremek. (l.c. 199) was based on *Gamble* 15021 and *Campbell* 60 and 259. It agrees fully with *P. indica* L. var. *tomentosa* (Roxb. ex Sm.) Hook.f. in the hairiness of stem, leaves and inflorescence. There is no distinction in floral characters and it is therefore synonymous with the latter variety.

P. blanda Bremek. (1934: 94) was based on specimens (including type) of *P. indica* L. var. *montana* Hook.f. (1880: 150) and some Indian specimens belonging to *P. indica* L. var. *minor* Hook.f. (l.c.) and *P. breviflora* DC. var. *subcoriacea* Gamble. This species appears to be limited to Sri Lanka only. The Indian specimens included under it by Bremekamp are different and are treated under other species or varieties.

P. thomsonii Bremek. (1934: 99) var. *glaberrima* Bremek. (= *thomsonii*) was based on specimens belonging to *P. indica* var. *indica*. It fully agrees with *P. indica* L. var. *indica* and deserves to be merged with it. *P. thomsonii* Bremek. var. *puberula* Bremek. (l.c.) was based on specimens (including types) belonging to *P. indica* L. var. *minor* Hook.f. (1880: 150). It is distinct from *P. indica* in the leaves being narrowly oblanceolate or elliptic-lanceolate, acute or acuminate at apex, calyx teeth long, subulate, acute, puberulous, cymes puberulous. It deserves to be treated as a distinct species. Hence a new combination is made, raising it to specific status.

The taxonomic status and synonymy of *P. indica* L. are as follows.

Pavetta indica L., Sp. Pl. 110. 1753 (Type: Sri Lanka, *Herman* 56 BM); Hook.f. Fl. Brit. Ind. 3: 150. 1880; Bremek. in Fedde Repert. 37: 118. 1934.

Ixora indica (L.) Kuntze, Rev. Gen. Pl. 1: 286. 1891.

I. paniculata Lam. Encycl. 3: 344. 1789.

I. pavetta Roxb. Hort. Beng. 11. 1814 *nom. nud.* & Fl. Ind. 1: 396. 1820, *non* Andrews, 1799.

Pavetta alba Vahl. symb. Bot. 3: 11. 1794.

P. obtusa Pers. Syn. 1: 131. 1805.

(a) var. **indica**

P. indica L. var. *glabra* Blatter & Hallberg in J. Bombay nat. Hist. Soc. 36: 792. 1933.

P. indica L. var. *glabra* Bremek. in Fedde Repert. 37: 119. 1934.

P. indica L. var. *indica proper* Hook.f. Fl. Brit. Ind. 3: 150. 1880.

P. thomsonii Bremek. var. *glaberrima* Bremek. (*=thomsonii)* in Fedde Repert. 37: 99. 1934 (Type: Mysore, *Thomson s.n.*, holo. K!, photo CAL!) syn. nov.

P. thomsonii Bremek. var. *thomsonii* B.D. Sharma *et al.* Fl. Kern. 131. 1984.

P. blanda Bremek. in Fedde Repert. 37: 94. 1934, p.p.

(b) var. **glabrescens** (Kurz) Deb et Rout comb. nov.

Basionym: Ixora tomentosa var. *glabrescens* Kurz, For. Fl. Brit. Burm. 2: 19. 1877 (Type: Burma, Pegu, 23.2.1871, *S. Kurz* 3057 CAL, right hand specimen is selected as the lectotype, the other sheet of the same no. is isolecto.).

P. tomentosa Roxb. ex Sm. var. *glabrescens* (Kurz) Bremek. l.c. 114.

P. amabilis Bremek. in Fedde Repert. 37: 100. 1934 (Type: Upper Burma, 1911-12, *S.M. Toppin* 3032, holo. E!, iso. CAL!) syn. nov.

P. assamica Bremek. in Fedde Repert. 37: 119. 1934 (Type: Assam, Guahati, *Simons* 16, holo. K!, photo CAL!) syn. nov.

P. bengalensis Bremek. in Fedde Repert. 37: 99. 1934 (Type: Bengal, Nov. 1850, *Hooker & Thomson s.n.*, holo. K!, photo CAL!) syn. nov.

P. griffithii Bremek. in Fedde Repert. 37: 99. 1934 & 47: 22. 1939 (Type: Bhutan, *Griffith* 2114, holo. K!, photo CAL!) syn. nov.

P. indica L. var. *polyantha* Hook.f. Fl. Brit. Ind. 3: 150. 1880 (type: Meghalaya, Silhet Mt. (Jowai), *F.De Silva s.n.* ex *Wall. Cat.* 6176, holo. K!, photo & microfische CAL!).

P. indica Wall. Cat. 6175 F, *nom. nud.*

P. neglecta Bremek. in Fedde Repert. 37: 92. 1934 (Type: Mizoram, S. Lushai Hills, Thady forest, 1050 m, Aug. 1928, *Wenger* 214, holo. K!, photo CAL!) syn. nov.

P. polyantha Wall. Cat. 6176, *nom. nud.*

P. polyantha (Hook.f.) Bremek. in Fedde Repert. 37: 103. 1934 & 47: 22. 1939. syn. nov.

P. polyneura Bremek. in Fedde Repert. 37: 119. 1934 (Type: Burma, S. Tenasserim, Kyein Chaum, 12. 2. 1926, *Maung Law Tek* 1379, holo. K!, photo CAL!) syn. nov.

P. rothiana DC. Prodr. 4: 1830.

P. villosa Heyne in Roth, nov. sp. 89. 1821, *non* Vahl 1794.

As per Art. 56.1 of ICBN (1988) the new combination at the varietal status is necessary.

(c) var. **tomentosa** (Roxb. ex Smith) Hook.f. Fl. Brit. Ind. 3: 150. 1880.

P. tomentosa Roxb. ex Smith in Rees Cycl. 26, n. 2, 1819 (Type: *Roxb. ill.* no. 169 CAL! as in Wight Icon. t. 186. 1840); Bremek. in Fedde Repert. 37: 113. 1934 p.p.

P. tomentosa Roxb. ex Smith var. *roxburghii* (Kurz) Bremek. l.c. 114.

P. indica L. ssp. *tomentosa* (Roxb. ex Smith) Bennet, Fl. How. 356. 1979 & Name change. Fl. Pl. 415. 1987.

P. indica L. var. *mollis* Bremek. in Fedde Repert. 37: 119. 1934 (type: Andhra Pradesh, Cuddaph dist., Guvalacharam Ghat, 300 m, July 1884, *J.S. Gamble* 15021, holo. K!, photo CAL! iso. CAL! MH!) syn. nov.

P. praecox Bremek. in Fedde Repert. 37: 114. 1934 (Type: Karnataka, Canara, Belgaum, April 1831, *Ritchie* 352, holo. K!, photo CAL!) syn. nov.

Ixora roxburghii Kuntze, Rev. Gen. Pl. 1: 296. 1891.

I. tomentosa Roxb. Hort. Beng. 11. 1814, *nom. nud.* & Fl. Ind. 1: 396. 1820

(d) **P. blanda** Bremek. in Fedde Repert. 37: 94. 1934 p.p. (excl. synonyms and Indian specimens).

P. indica L. var. *montana* Hook. f. Fl. Brit. Ind. 3: 150. 1880 (Type: Sri Lanka, 900-1200 m, 1854, *Thwaites, C.P.* 2456, holo. K! iso. BM!

CAL!).

P. indica Thw. Enum. Pl. Zeyl. 155. 1859 (excl. var. r & O).

(e) **P. minor** (Hook.f.) Deb & Rout comb. et stat. nov.

Basionym: *P. indica* L. var. *minor* Hook.f. Fl. Brit. Ind. 3: 150. 1880 (Type: Tamil Nadu, Shevaghiry hills, *R. Wight s.n.* (*Kew Distrib. No.* 1483), holo. K!, photo CAL!).

P. blanda Bremek. in Fedde Repert. 37: 94. 1934 p.p. (excl. type from Sri Lanka)

P. thomsonii Bremek. var. *puberula* Bremek. in Fedde Repert. 37: 99. 1934.

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NEW DESCRIPTIONS

PUNTIUS SHARMAI, A NEW CYPRINID FISH FROM MADRAS[1]

A.G.K. Menon and K. Rema Devi[2]

(With a text-figure)

Puntius sharmai sp. nov., a small puntiid, is described from Madras. It is closely related to *Puntius fraseri* Hora & Misra (1938) known from Deolali, the headwaters of Godavari in Maharashtra.

Introduction

A recent collection of small puntiids from freshwater tanks around Madras contained an interesting species hitherto unknown to science, which is described here. Descriptions are based on measurements with dial callipers with an accuracy of 0.02 mm and are presented as times in standard length (SL) and head length (HL) with the mean, followed by the range in parentheses.

Diagnosis: A small sized *Puntius* with one pair of barbels, a serrated osseous dorsal spine, an incomplete lateral line, with more than 42 scales along the sides, considerably elongated fins, a dark lateral band ending in a blotch in caudal base.

Holotype: 1 ex., 27.0 mm SL, Mogappair, West Annanagar, Madras, Tamil nadu, 4 Dec. 1990, Coll: Malaria Research Centre, Madras, Reg. No. F. 3768, Zoological Survey of India, Southern Regional Station, Madras.

Paratypes: 2 exs., 24.5 and 25.5 mm SL, Tenneri Tank, near Kunrathur, Tamil Nadu, 6 Dec. 1975, Coll: M.B. Raghunathan, Reg. No. F. 3771.

Puntius sharmai sp. nov.
(Fig. 1)

Description: D.3/8; P.1/12-13; V.1/8; A.3/5; C.1/17/1; Ll. 42; L.tr. $7^1/_2/6^1/_2$; Predorsal scales about 15.

Head small, 4.89 (4.78-5.04) in TL, 3.56 (3.51-3.62) in SL. Width of head 1.84 (1.75-2.0), its height 1.35 (1.31-1.42), length of snout 3.34 (3.11-3.55), eye diameter 3.26 (3.06-3.45), interorbital width 3.16 (2.95-3.48) in head length. Maxillary barbels very small, 2.47 (2.27-2.86) in eye diameter. Depth of body slightly greater than head length and is 4.78 (4.67-4.96) in TL and 3.48 (3.38-3.59) in SL. Caudal peduncle long and narrow, its least height being 1.31 (1.11-1.55) in its length

Predorsal distance 2.09 (1.90-2.19), postdorsal distance 1.96 (1.84-2.09), prepelvic distance 1.95 (1.93-1.98), preanal distance 1.42 (1.39-1.44) in SL; distance from pectoral origin to pelvic origin 3.72 (3.67-3.81), from pelvic to anal origin 4.79 (4.55-5.06), from pectoral base to anus (length of body cavity) 2.23 (2.17-2.33) in SL.

The fins are well developed and the anterior rays are prolonged. Dorsal situated midway between tip of snout and caudal base; the first spine is very small and the third spine is well developed, osseous and serrated. Predorsal distance 0.94 (0.89-0.97) in postdorsal distance. Height of dorsal fin 3.86 (3.60-4.01) in SL, 1.11 (1.04-1.17) in body depth, and 1.08 (1.01-1.14) in HL. Pectoral fin long and extends to pelvic base, and is 1.33 (1.32-1.37) in HL, 4.75 (4.67-4.80) in SL; anterior rays of pelvic fin prolonged and extend beyond anal origin and is 4.44 (4.31-4.53) in SL, the first two branched rays of anal fin are greatly prolonged and are 3.50 (3.49-3.51) in SL. Caudal deeply forked, considerably longer than head and is 2.67 (2.55-2.88) in SL.

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[2]Zoological Survey of India, Southern Regional Station, 100, Santhome High Road, Madras 600 028.

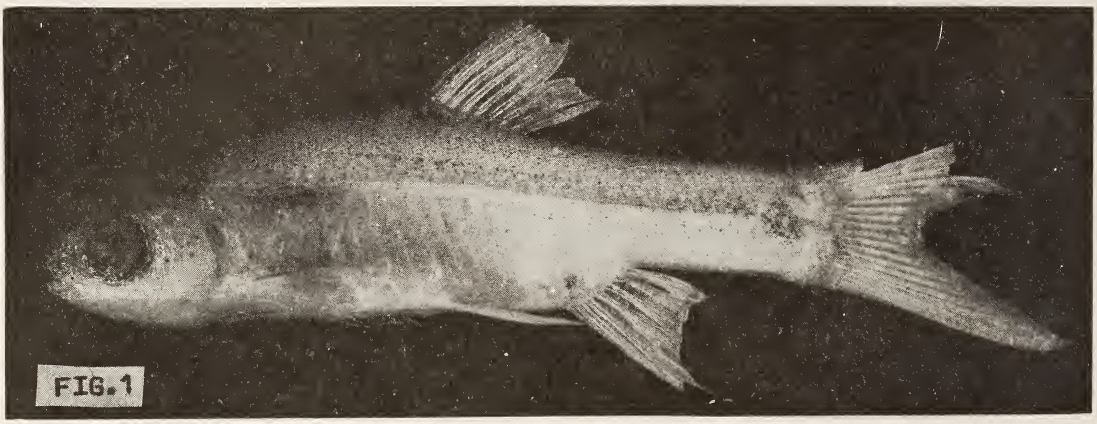

Fig. 1. Lateral view of *Puntius sharmai* sp. nov., 27.0 mm SL.

Scales small, numerous, 42 scales up to caudal base; lateral line pores extend up to the seventh scale.

Sensory canal pores as radiating vertical rows from below eye on cheek. About 12 minute gill-rakers are present on the first gill arch.

In formaldehyde, the specimens appear dark along the dorsal surface. Along the middle of the body there is a pale horizontal streak; above this a dark band is seen which ends in a blotch on the caudal base. Base of the anterior rays of the dorsal fin dark; a dark spot above anterior anal base.

The new species is closely allied to *Puntius fraseri* Hora and Misra (1938, *JBNHS* 40: 20-38), described from Darna river, Deolali, Maharashtra, but can be easily distinguished by its more streamlined body, the depth of body—is 4.78 (4.67-4.96) in TL, 3.48 (3.38-3.59) in SL, (4.3-4.4 in TL and 3.2 in SL in *P. fraseri*)—and smaller head, 4.89 (4.78-5.04) in TL, 3.56 (3.51-3.62) in SL, (5.4 in TL and 4 in SL in *P. fraseri*). The fins are greatly prolonged in the new species; the pectoral reaches pelvic origin whereas in *P. fraseri* it is separated by a considerable distance; the anal rays are prolonged and extend close to the caudal base while in the latter it is shorter and separated from caudal base, by a considerable distance. The lateral line pores extend up to the seventh scale in *P. sharmai* (upto the eighth to tenth scales in *P. fraseri*). The new species is considered as a useful larvicidal fish for use in malaria control.

Etymology: The fish is named after Dr. V. P. Sharma, Director, Malaria Research Centre, New Delhi, in recognition of his keen interest in the study of indigenous larvivorous fishes of India.

Acknowledgements

We are greatful to the Director, Zoological Survey of India, for providing necessary facilities.

ON A NEW SPECIES OF *ORASEMA* CAMERON (HYMENOPTERA: EUCHARITIDAE), WITH A KEY TO INDIAN SPECIES[1]

S. Snehalatha and T.C. Narendran[2]

(With nine text-figures)

A new species, viz. *Orasema indica* from Kerala, is described. A dichotomous key to Indian species of *Orasema* Cameron is provided.

Introduction

In recent years we have collected considerable material belonging to the chalcidoid family Eucharitidae. Among these we came across an interesting new species of *Orasema* Cameron from Kerala. The new species is described below with a key for separation of Indian species of the genus. So far only two species are known from the Indian subcontinent (Das 1963, Kerrich 1964, Narendran 1985,1986).

Orasema indica sp. nov.

FEMALE: Length 2.38 mm. Head and thorax dark green with metallic reflections; mandibles yellow with dark brown tips; eye yellowish white; scape, anellus and pedicel very pale yellow, flagellar segments brownish yellow, club yellowish brown; ocellus pale yellow; fore and mid coxae dark brown, hind coxa concolorous with thorax with its apex being dark brown; trochanter and femur dark brown except the apices of femur being pale yellow; tibia and tarsus pale yellow; claws dark brown; petiole concolorous with thorax; gaster dark brown; wing hyaline, veins yellow.

Head convex, transverse, slightly broader; head emarginate when viewed from dorsal side (Fig. 2) with lateral ocellus very near to occipital margin; head clearly smooth without any punctures or reticulations; supra-clypeal area rather rectangular, delimited by distinct furrows on sides, below and upper region (Fig. 1); antenna 11173 (Fig. 5), elongate with funicle segments well separated, scape 1.9 x length of first flagellar segment; POL 1.3 x OOL; POL 1.9 x LOL.

Dorsum of thorax highly reticulate; scapulae with slight transverse reticulations, axilla broadly meeting in middle, scutellum acuminate; propodeum alveolate on sides with striation in middle; mesopleuron smooth except in middle, with sculptures more or less in an inverted Y-shaped form (Fig 4); sm:m:pm = 8.6:5.8:2.8 (Figs. 6-7).

Petiole elongate with longitudinal striations, more or less 4.8 x its breadth.

Gaster globose, smooth and shiny (Fig. 8).

MALE : Length 2.35 mm.

Male differs from female in having more elongated antenna (Fig.9) and petiole; scape is almost equal in length to first flagellar segment.

Host: Unknown.

Holotype: Female. INDIA: Kerala, Trichur, April 1986, T.C. Narendran (DZCU). Deposited in Dept. of Zoology, University of Calicut, Regd. No. SL 151.

Paratype: Male of same data of holotype Regd. No. SL 145 (DZCU).

Key to Indian species of *Orasema* Cameron

1. Supra-clypeal area distinctly delimited at sides; head clearly smooth without any puncturations above; petiole 4.8 x its breadth .... *O. indica* sp. nov.
— Supra-clypeal area without any distinct delimitations ....2.
2. Sculpture on supra-clypeal area extremely fine and quite distinct; head with reticulate sculpture not notably coarser between ocellus and eye .... *O. assectator* Kerrich
— Supra-clypeal area smooth and shining; head with reticulate sculpture notably coarser between ocellus and eye .... *O. initiator* Kerrich

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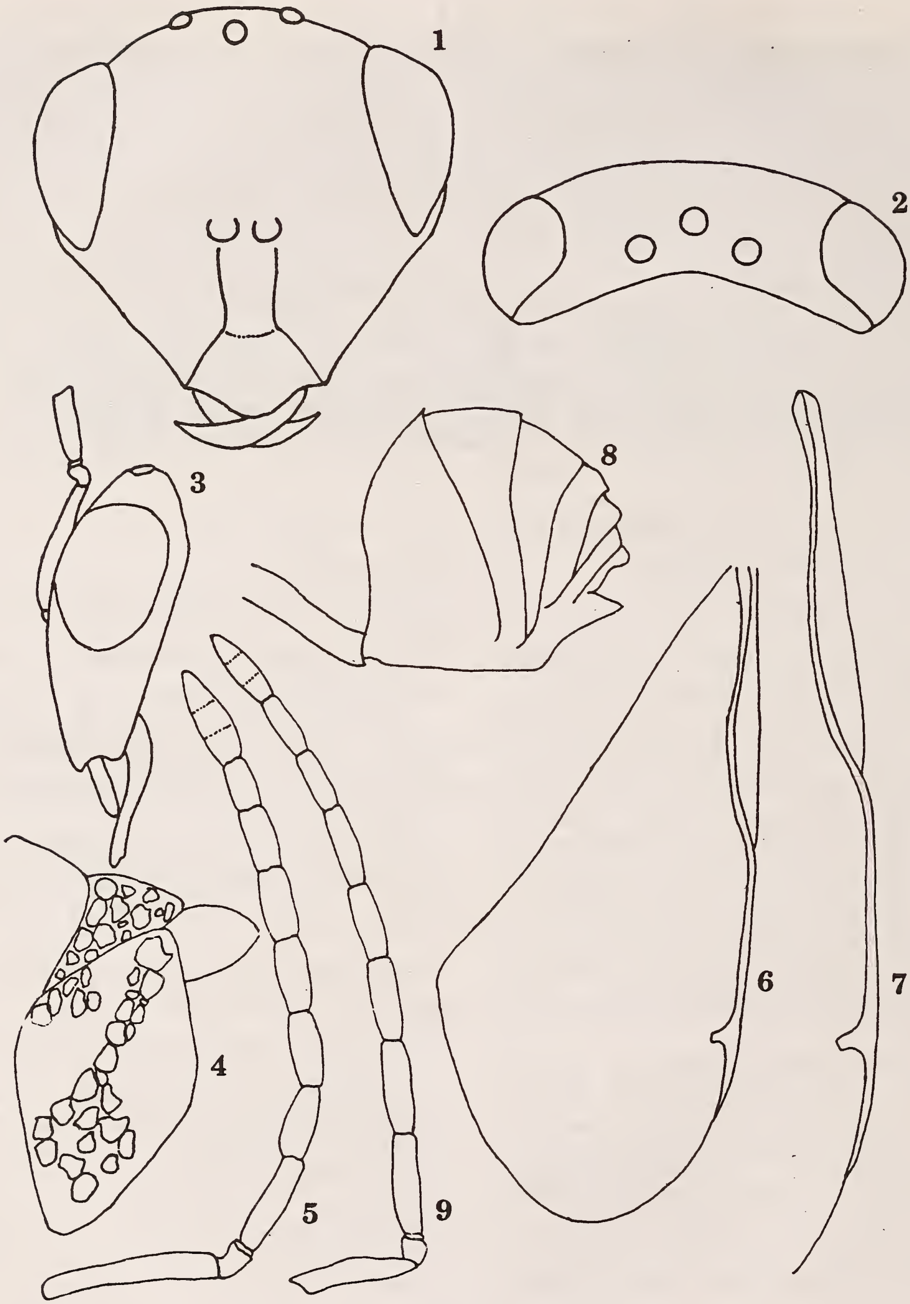

Figs. 1-9. *Orasema indica* sp. nov.
1. Head, frontal view; 2. Head, dorsal view; 3. Head, lateral view; 4. Mesopleuron; 5. Antenna; 6. Forewing; 7. Forewing venation enlarged; 8. Gaster; 9. Male antenna.

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One of the authors (S.S.) is grateful to the University of Calicut for financial assistance for undertaking studies on Indian Eucharitidae.

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A NEW FISH OF THE GENUS *PUNTIUS* HAMILTON (OSTARIOPHYSI : CYPRINIDAE) FROM GOA[1]

B.F. CHHAPGAR[2] AND S.R. SANE[3]

(With two plates)

Among the live fish exported from India for the pet trade is one popularly called indigo barb (*Barbus narayani*). It is conjectured that this fish may have been identified as such due to its colour resemblance to *Puntius narayani*, recorded by Hora in 1937 from the Cauvery river in Coorg. On closer inspection, it was found that the indigo barb is actually a new species. We are naming it *Puntius setnai*. [Raj Tilak (1969) did not come across this species in Goa.]

Puntius setnai sp. nov.

Specimens studied: Holotype; total length 47 mm, standard length 35.5 mm, from Sanguem, Goa. Paratypes; 24 exs. 40 to 57 mm total length, from clear streams in Sanguem and Ponda, Goa. The holotype and some of the paratypes will be deposited with the Zoological Survey of India, Calcutta.

Diagnosis: This species can be distinguished by (1) absence of barbels, (2) last undivided ray of dorsal fin osseous and serrated, (3) complete lateral line, (4) 20 scales along lateral line and (5) two vertical dark bands on the body (during life).

DESCRIPTION

D. 3/8, P.1/12-14, V. 1/8, A. 2/5, C. 19. L.1. 20 (17-22); l. tr. 5/3-4.

Head and body compressed, belly rounded. Dorsal and ventral profiles greatly arched, the former more so than the latter. Head short, conical. Eyes lateral. No tubercles on cheek and snout. Barbels absent. Dorsal fin inserted slightly nearer tip of snout than caudal base. Last unbranched ray of dorsal fin osseous and serrated. Caudal fin forked, lobes more or less equal, slightly pointed, about twice longer than median rays. Lateral line complete, typically perforating 20 scales. It runs horizontally up to the posterior border of the first dark band, then dips down and, at the seventh scale, again runs horizontally in a gentle arc to the tail. PDS 7, circumpeduncular $^1/_2$ 5 $^1/_2$.

Morphometry: (of holotype, all measurements in millimetres) Total length 47, standard length 35.5, body depth 15.33, head length 9.67, head depth 8.33, predorsal length 19.95, post-dorsal length 20.84, pre-pelvic length 20.40, preanal length 28.0, length of caudal

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peduncle 5.83, depth of caudal peduncle 6.0, snout length 1.92, eye diameter 3.92, dorsal fin length 5.83, dorsal fin depth (damaged) 7.0 (?), pectoral fin length 8.50, pelvic fin length 8.50, anal fin depth 7.50, anal fin length 5.17, caudal fin length 10.44.

Depth of head in head length (HL) 1.16, snout in HL 5.04, eye diameter in HL 2.47, predorsal/post-dorsal length 0.96, HL in standard length (SL) 3.67, body depth in SL 2.32, length of anal fin in SL 6.87, length of caudal peduncle in SL 3.40, depth of caudal peduncle in SL 5.92, length of body cavity in SL 2.10, predorsal length in SL 1.92, prepelvic length in SL 1.84, postorbital length in SL 6.80, caudal peduncle depth/caudal peduncle length 1.03.

Colouration: During life, the general body colour is olive grey. Two vertical dark, oval bands are prominent but do not extend up to the ventral border (Plates 1a, 2a). The first is narrow and covers scales 3, 4 and the front margin of scale 5. The second dark band is more rounded, occurs above the posterior part of the anal fin and covers scales 16, 17. In addition, there is a faint grey elongated patch below the rear portion of the dorsal fin which covers scales 10, 11 and a small portion of scale 9. On both sides of the rear dark band, the body is creamy white. In the breeding season, the whole body in the male acquires a golden yellow sheen. All the fins are colourless and transparent. (In the colour plate, the fins appear black because the fish was photographed against a black background. Similarly, the white on the body is due to reflection of light of the electronic flash from the body.)

Sexual dimorphism: In adult males, the dorsal fin is suffused with red, while the pelvic fins are edged on the outer side with white.

Colour after long preservation: The pale grey patch on the body below the rear portion of the dorsal fin turns very dark, so that the fish appears to have three dark bands (Plate 2b). The body changes colour from olive grey to orange brown.

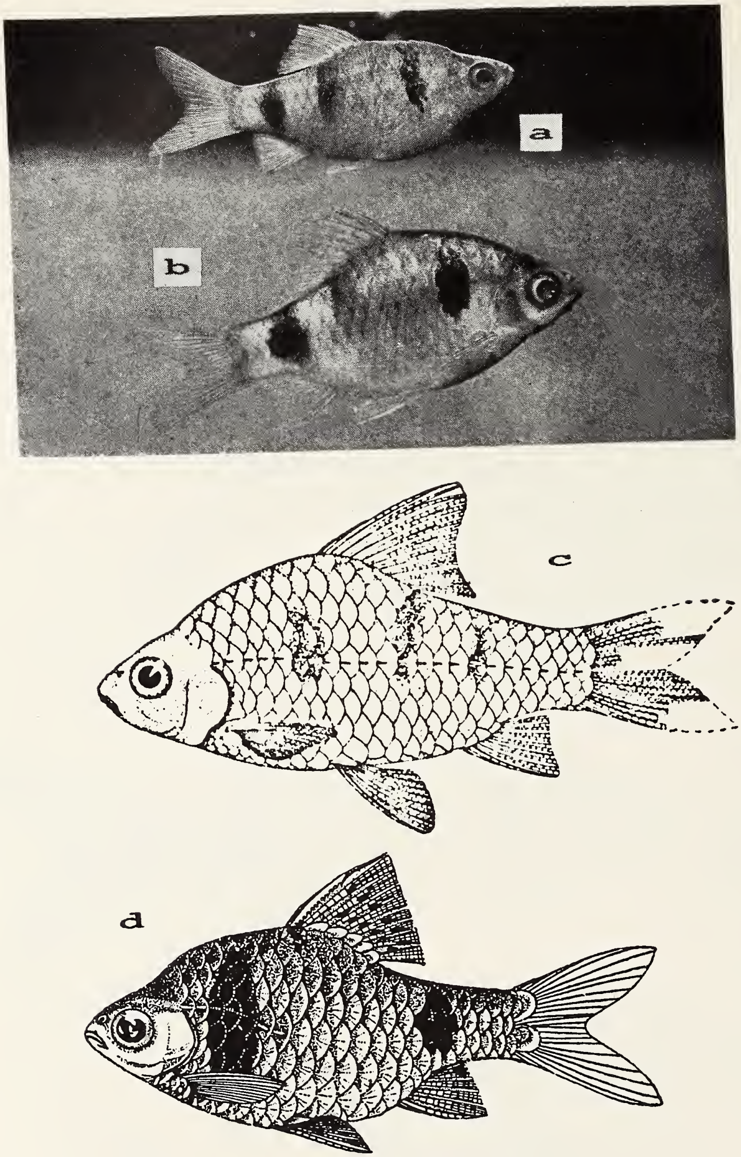
Etymology: The new species is named after late Dr S.B. Setna, first Director of Fisheries of the erstwhile Bombay State, whose dynamism led to the establishment of a separate Department of Fisheries, which was prior to 1945, only a Section of the Industries Department.

Discussion

Several barbs have two dark spots or bands on the body. Three species that closely resemble *Puntius setnai* sp. nov. are *Puntius cumingii* (Gunther 1868) (Plates 1c, 2c) from Sri Lanka, *P. bandula* Kottelat & Pethiyagoda (Plate 1b), also from Sri Lanka, and *P. narayani* Hora (Plate 2d) from Coorg (Karnataka). *Puntius bandula* has an incomplete lateral line, and the rear dark band reaches up to the ventral border of the body. Moreover, the dorsal, anal and pelvic fins are black. In *P. cumingii*, too, the lateral line is incomplete, and each scale has a black border in front. The dorsal and pelvic fins of specimens from northern Sri Lanka are reddish, while those from the south have yellowish fins. In *P. narayani*, the last unbranched ray of the dorsal fin is a weak, articulated spine.

Since the light grey patch between the two dark bands in *Puntius setnai* sp. nov. darkens after long preservation, this fish then has the appearance of having three dark bands. Females and juvenile males of *Puntius nigrofasciatus* (Gunther) from Sri Lanka also have three bands, but their body height is greater compared to *P. setnai* sp. nov. Each scale has a central silvery white spot, and the three dark bands extend completely from the dorsal border down to the ventral border (Plate 1d). Males in the breeding season (Plate 1e) develop a crimson red colouration over the body and caudal fin. This varies in intensity and, in males in full breeding fervour, the entire body may become almost a uniform black, with just a trace of crimson (Plate 1e). The dorsal, pelvic and anal fins in the male are smoky grey.

a. *Puntius setnai* sp. nov. (see text for explanation of true colours); b. *P. bandula*; c. *P. cumingii*; d. *P. nigrofasciatus*, female; e. *P. nigrofasciatus*, male in breeding livery.



a. *Puntius setnai* sp. nov. freshly preserved; b. *Puntius setnai* sp. nov. after prolonged preservation; c. *P. narayani* (after Hora 1937); d. *P. cumingii,* showing two rows of black spots on dorsal fin and streaked anterior borders of scales (after Deraniyagale 1952)

ADDENDA AND CORRIGENDA

Page 357 — Specimens studied : Add
Holotype (Reg. No. FF 2766) of ZSI, Calcutta.
Date of collection 1-3-1985. Paratypes (Reg. No. FF 2767).

Page 358 — Left column
Colouration : Line 4 should read : (Plates la, 2b).

Page 358 — Left column
Colour after long preservation : Bottom line should read : 2a).

Page 358 — Right column
Discussion : Line 4 should read : (Plates 1c, 2d).

Page 358 — Right column
Discussion : Line 7 should read : (Plate 2c).

Plate 2 (facing page 359). Captions for illustrations.
a should read: *Puntius setnai* sp. nov. after prolonged preservation.
b should read: *Puntius setnai* sp. nov. freshly preserved.

Table 1 (page 359) — Number of dark bands for *Puntius narayani* should read 3, instead of 2.

TABLE 1
DISTINGUISHING CHARACTERS OF FIVE BARBS

	Puntius cumingii	*Puntius bandula*	*Puntius narayani*	*Puntius nigrofasciatus*	*Puntius setnai* sp. nov.
Lateral line	Incomplete	Incomplete	Complete	Complete	Complete
Last unbranched dorsal ray	Osseous, serrated	Osseous, serrated	Feeble, articulated	Osseous, serrated	Osseous, serrated
Number of dark bands on body	2	2	2	3	2 (during life), 3 (on preservation)
Colour of dorsal fin	Red or yellow, with two rows of black spots on fin-rays	Black	Not stated	Smoky grey	Colourless

The characters listed in Table 1 can be used to distinguish the aforestated five barbs.

The scales on the lateral line of *Puntius setnai* sp. nov. show a remarkable variation in number, not only in different specimens but also on the two sides of the same specimen. While the typical number of lateral line scales is 20, a random sampling showed 19-20, 20-21, 17-20, 18-19 and 21-22. It is a matter of speculation whether such variation occurs only in this species; it would be worthwhile to examine other fishes for this trait.

Too much emphasis has been placed on fin-ray count for distinguishing barbs. Of the 70 species of barbs for which Day (1875) has given fin-ray formulae, as many as 49 have three undivided dorsal rays, while 45 have eight branched dorsal rays. All but 14 species have 19 caudal rays, and all but 11 have nine rays on the ventral fins. Rays on the anal fins vary from seven (in 39 species) to eight (in 30 species), only *Barbus spinulosus* having ten.

The colour pattern in some species of barbs is different in juveniles and adults (see Kortmulder and van der Poll 1981).

ACKNOWLEDGEMENTS

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MISCELLANEOUS NOTES

1. GRIZZLED GIANT SQUIRREL *RATUFA MACROURA* THOMAS AND WROUGHTON AT CAUVERY VALLEY IN KARNATAKA

The grizzled giant squirrel *Ratufa macroura* Thomas and Wroughton is an endemic species with a disjunct distribution in the peninsula. The species is known to be restricted to a small area of deciduous forests in the Srivilliputtur forests (Borges 1990, Ramachandran 1989) and Kudirayar valley (Davidar 1989) on the eastern slopes of the Western Ghats in Tamil Nadu. It has also been recorded in the Chinnar Wildlife Sanctuary in Kerala (Ramachandran 1989).

However, during a trip to Muttatti (398 m above msl, 12° 18′ N, 77° 18′ E) a popular pilgrimage centre (*c*.120 km south of Bangalore) on the banks of river Cauvery, on 21 April 1991, we sighted a *R. macroura* on an *Albizzia amara* tree. The spot is about half a kilometre upstream from Muttatti.

Muttatti falls within the Basavanabetta State Forest, which comprises of boulder strewn hills covered by dense mixed jungle with bamboo. The Cauvery river borders the State Forest on the southern side, where the riparian habitat is prevalent. Tree species dominating the riparian zone are *Terminalia arjuna, Tamarindus indica, Mangifera indica, Pongamia glabra, Albizzia amara* and *Syzygium* sp.

On noticing our presence the squirrel tried to hide by pressing itself close to the branch and lying motionless. A little later, it began feeding on the tender leaves of *A. amara* and moved on to feed on the tender leaves of a neighbouring tamarind tree. In the meantime a second individual was spotted on another *A. amara* in bloom about 75 m from where the first individual was seen. In a short while the former joined the latter and both were observed pulling the blossoms with their forelimbs and feeding on the pollen without plucking the flower. The behaviour of taking the stamens into the mouth and pulling them out without actually damaging them indicated that the squirrels were feeding on the pollen of *A. amara*. Later one of them moved closer to the other and both started to nuzzle each other. One of the squirrels was observed chasing away a threestriped palm squirrel *Funambulus palmarum* Wroughton which approached too close. It was also observed that one of the pairs of *R. macroura* was gnawing at the loose bark of an *Albizia* tree.

Two of us (SK and JNP) visited the place again with two others (G.S. Aditya and M.S. Jayanth) on 27 and 28 April 1991. On 27 April, we surveyed a stretch of approximately 6 km of the riparian zone between Muttatti and Bhimeshvari (404 m above msl; 12° 18′ N, 77° 17′ E). We came across 16 dreys, but only one individual about 4 km upstream from Muttatti village. On 28 April, we covered a stretch of 16 km downstream from Muttatti to Sangam (373 m above msl; 12° 17′ N, 77° 26′ E), the confluence of rivers Arkavathy and Cauvery. We came across one individual about 14 km from Muttatti and 19 dreys. Both the squirrels seen on 27 and 28 April appeared very shy, hiding themselves from our view and lying motionless on the branch for quite some time. The observations of Raja (1983) indicate that *R. macroura* is very vocal. However, all the four individuals we came across in the Muttatti area were silent. We also did not hear any calls in the area which could be those of any other *Ratufa* species.

Muttatti area is inhabited by Soliga tribals. On enquiring with a few Soligas,we learnt that the tribals regularly hunt *R. macroura* for meat. According to them, the squirrel is known to come down from trees to drink water from the river and at such times is particularly vulnerable. The squirrel, popularly known among the tribals as *Bettaluma,* is also known to inhabit the riparian zones on the opposite bank, which come under the Chikkayalur Reserve Forest. The habitat there too is similar to that of Basavanabetta State Forest. Possible predators of these squirrels could be the crested serpent eagle *Spilornis cheela* (Latham) and the grey-headed fishing eagle *Ichthyophaga ichthyaetus* (Horsfield) which also inhabit the same habitat in the area.

Hitherto *R. macroura* has been recorded only in Tamil Nadu and Kerala; our sightings in the Muttatti area constitute the northernmost record of the species and also probably the first report from Karnataka.

More detailed surveys in appropriate habitats in

between Srivilliputtur forests, Chinnar Wildlife Sanctuary and Muttatti area may throw more light on the distribution and abundance of *R. macroura*. Such surveys may also help in identifying potential habitats for protection.

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October 22, 1991

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2. ESTIMATION OF DENSITY OF IBEX *CAPRA IBEX* LINN. IN PIN VALLEY NATIONAL PARK, HIMACHAL PRADESH

(With a text-figure)

The Pin Valley National Park in Lahaul-Spiti district, Himachal Pradesh, was set up in 1987. Biogeographically, this area has been included in Zone 1B, i.e. the Tibetan Plateau (Rodgers and Panwar 1989). The mean elevation of the Park is 4250 m above sea level (Morgain 1975). There is virtually no information on the status of wildlife of this difficult terrain. The local Budhist population does not shoot wild animals because of religious sentiment. The ibex *Capra ibex sibirica* is a major species in the Park. No density estimates exist for Himalayan ibex in its entire range.

In order to assess the status of wildlife in the Park, preliminary surveys were done during 1988-89. The surveys showed that ibex move downwards into the valleys after snowfall in late October or early November. By late October, the migratory graziers who come largely with sheep also leave the Park. Therefore, November was selected as being the best period for a census of ibex.

The Park was divided into seven census grids along the seven major rivulets (Fig. 1). Seven parties, each consisting of one observer (Wildlife Department personnel) and two labourers were allotted one census grid (or transect line). The length of the transects varied between 6 and 11 km and the breadth between 1 and 1.5 km. 500-750 m were scanned on either side of each transect, using 10 x 55 binoculars.

Practise censuses were carried out from 22 to 25 October 1989, and the actual census from 12 to 14 November 1989.

RESULTS AND CONCLUSION

The observations made during the census are shown in table 1.

TABLE 1

	Name of the transect line (see Fig. 1)	Area covered (sq. km.)	Total No. of Ibex seen
(1)	Kidul Cho up to Ula	11 x 1 = 11	7
(2)	(i) Kidul Cho to Thango	6 x 1.5 = 9	46
	(ii) Thango to Nakpozamba	6 x 1 = 6	Nil
(3)	Thango to Debsa	7 x 1 =7	46
(4)	Khaminger to Kangla	8 x 1.5 = 12	33
(5)	Larang pasture to Larang La and Tari Khango	10 x 1 = 10	21
(6)	Chhochhden to Thangpat	11 x 1 = 11	21
(7)	Chhochhden to Pradey-Chorak–Nimish Khango	10 x 1= 10	Nil
	Total =	76 sq. km	174

$$\text{Density of Ibex} = \frac{174}{76} = 2.29 \text{ (Ibex per sq. km)}$$

The average breadth of the valleys scanned (1 or 1.5 km) as mentioned above is a fact, visual estimation by the observers.

The results given above are purely based on actual observations and do not include any allowance for the unseen number of ibex in the survey area.

There was little chance of overlapping or double counting of ibex as the seven census grids were away from each other. At the time of compilation of data, the timing and sites of ibex sightings were taken into account to avoid double counting.

The area surveyed during census (76 sq. km) is 11.26% of the total area (675 sq. km) of the Pin

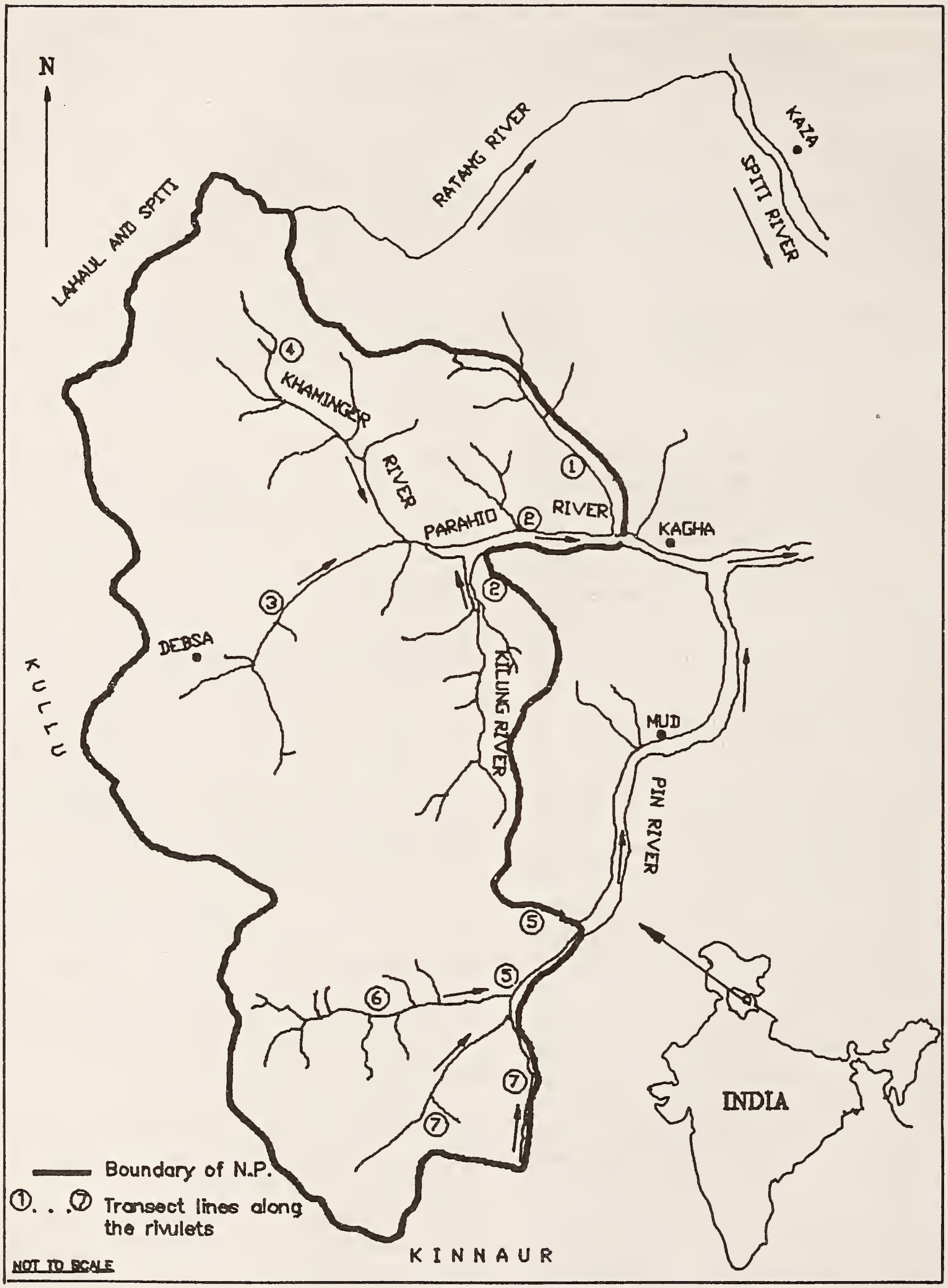

Fig. 1. Map of Pin Valley National Park, showing transect lines along the rivulets.

Valley National Park. A major portion of the Park is covered by glaciers, etc. which may not be considered as ibex habitat. The total population of ibex in the Park could be between 700 and 1200 animals.

Recommendations: This population estimation exercise must be used as benchmark data by future Wildlife managers. The influence of grazing by migratory sheep and goats should be investigated further. A management prescription has been proposed that involves a grazing closure programme that will lead to total elimination of grazing in all the major pastures inside the National Park (Pandey 1990). It is recommended that these results be verified in similar weather conditions in November over a period of at least five years so that direct comparison can be made between counts associated with the grazing reduction.

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3. ON RARE CETACEAN SPECIES OFF SRI LANKA, INCLUDING THE KILLER WHALE *ORCINUS ORCA* (LINN.) (DELPHINIDAE : CETACEA)

An impetus to the study of Cetaceans off Sri Lanka was given by the declaration in 1979 of the northern portion of the Indian Ocean (20° 130′ E, and above 55° S) as a marine mammal sanctuary at a meeting of the International Whaling Commission (IWC). This was followed by a three-year study (1982-1984) of the large whales, specially of the sperm whale *Physeter macrocephalus* (Linnaeus) off Sri Lanka (see Alling *et al.* 1982). In addition, observations were made on small cetaceans. Alling (1985) examined the fishery by-catch at the fishery harbours of Beruwala (south coast) and Valaichenai and Trincomalee (east coast).

The Marine Mammal Programme of the National Aquatic Resources Agency (NARA) continued the study of the fishery by-catch and also recorded sightings of both large and small cetaceans during offshore cruises of 'R/v Samudra Maru' during the period 1985-1989.

During the period 1985-1989 we examined the landed catch at fishery harbours Negombo (on the west coast), Beruwala, Galle, Mirissa, Dondra, Kottegoda, Tangalle, Hambantota, Kalametiya and Kirinda (on the south coast). The number of monitoring days of the by-catch during the above period was 46 for Negombo, 44 for Beruwala, 28 for Galle, 52 for Mirissa, 47 for Dondra, Ganadara and Kottegoda and 8 for Tangalle, Hambantota, Kalametiya and Kirinda. During this study the following rare/infrequent species were recorded in the catch:

Killer whale *Orcinus orca* (Linn.): On 8 April 1986 a female was landed at Negombo by fishermen operating a 3.50 ton fishing vessel 50 km off Negombo. It was entrapped in the nylon gillnet and measured 277.5 cm from tip of snout to fluke notch. Its tooth count was 18 for each jaw. It had the striking black and white pigmentation typical of the species. Its body was cut up to be sold while the skull was procured and given by NARA to the University of Peradeniya.

Rough-toothed dolphin *Steno bredanensis* (Lesson): Five specimens, of which:

(i) Two specimens, a male and a female at Negombo fishery harbour. The male was net-entangled in May 1987 and measured 177.5 cm. The female was harpooned in February 1988, and measured 152.5 cm.

(ii) A single animal, a male was landed at Beruwala fishery harbour in February 1988. It was net-entangled and measured 223.75 cm in total length.

(iii) Two animals, a male and a female, were

landed at Mirissa fishery harbour in October 1985 (male, 222.5 cm harpooned) and July 1985 (female, net-entangled, 206.25 cm).

The percentage frequency of this species in the total landed catch of dolphins were 2.5% at Negombo, 0.75% at Beruwala and 1.6% at Mirissa for the period 1985-1989.

Melonheaded whale *Peponocephala electra* (Gray). 15 specimens. Of these:

(i) Seven specimens, two males and five females were landed at the Negombo fishery harbour. Of them two were in July 1985 and 1988, three in August 1987 and 1988 and two in October 1988. Three animals taken were found harpooned and the remaining four were a result of net entrapment. The total length measurements were for males 217.5 cm and 202.5 cm and for 4 females 227.5 cm, 221.25 cm, 185 cm and 127.5 cm (calf) respectively. These constituted 8.8% frequency of the total catch of dolphins at Negombo for the period 1985-1989.

(ii) Five individuals, three males and two females from Beruwala fishery harbour on 13 October 1987 and 18 October 1988, all being instances of gillnet entrapments. Two males measured 212.5 cm and 221.25 cm in total length while the females had a total length of 210 cm and 228.75 cm respectively. It represented 3.7% frequency of the total landed dolphin by-catch during 1985-1989 at this fishery harbour.

(iii) Two animals, one male and one female at the Mirissa fishery harbour also in October 1985. They were both harpooned, measuring 247.5 cm (male) and 232.5 cm (female). The percentage frequency of this species out of the total catch at Mirissa during 1985-1989 was 1.6%.

(iv) One female, measuring 207.5 cm was landed at Kottegoda in October 1987. It was a case of net entanglement. This represented 1.8% frequency out of the total dolphin by-catch landed at this fishery harbour during the period 1985-1989.

Pygmy killer whale *Feresa attenuata* (Gray): Two specimens in August 1985.

(i) A female, calf, 123.75 cm in total length was landed at Beruwala. It was net-entangled. This constituted 0.75% frequency of total dolphin by-catch at this fishery harbour during 1985-1989.

(ii) A male, 212.5 cm in total length landed at Galle fishery harbour. This represented 2.5% frequency of the total dolphin by-catch at Galle during 1985-1989.

Fraser's dolphin *Lagenodelphis hosei* (Fraser). Four individuals. Out of them:

(i) 1 male, 246.25 cm in total length was landed at Negombo fishery harbour in August 1988. It was net-entangled. This constituted 1.2% frequency of the total dolphin catch at Negombo during 1985–1989.

(ii) 3 individuals, all females, were landed at Mirissa fishery harbour. They measured 225 cm., 227.5 cm. and 232.5 cm in total length. Two animals were landed in September 1985 and the other in October 1985. All were found harpooned. The percentage frequency of the total dolphin catch at Mirissa during 1985-1989 was 2.5%.

During our study from 1985-1989 we did not observe the Irrawady dolphin, *Orcaella brevirostris* (Gray), in the fishery by-catch at any of the fishery harbours we visited and so are unable to confirm the records of Santarre and Santarre (1983) and Joseph *et al.* (1983) of this species in the Negombo fishery by-catch in 1982 and 1983.

Discussion

De Silva (1987) lists 23 Cetacean species off Sri Lanka including *Orcinus orca, Feresa attenuata* and *Peponocephala electra*. He has based the occurrence of *Feresa attenuata* on sight records whilst the record of *Pepono-cephala electra* is on a skull from Palk Strait in the Calcutta Museum mentioned by Blanford (1891). *Steno bredanensis* was first observed by Alling in the fishery by-catch studies she carried out at fishery harbours, Beruwala and Valaichenai and Trincomalee (east coast). She records three females of this species, one at Beruwala on 1 October 1983 and two at Trincomalee on 25 August 1983. She also found three specimens of *Feresa attenuata* at Trincomalee on 4 March and 2 August 1985. Prematunga *et al.* (1985) refer to two individuals, a male and a female of *Steno bredanensis* landed in July 1985 and one female *Lagenodelphis hosei* in the landed catch at Trincomalee on 25 January 1984. Leatherwood (in press) also reports of a female measuring 210 cm landed at Mirissa on 9 March 1986. Neither Alling nor Prematunga *et al.* have observed *Orcinus orca* not *Peponocephala electra* in the landed dolphin catch and the latter is recorded here for the first time in the fishery by-catch.

The first record of *Orcinus orca* is a sighting off Chilaw (North-western coast) by Holdsworth in

1872. Blandford (1891) also mentions its occurrence on the West coast. Joseph in Leatherwood (in press) reports of two entangled specimens, one at Kirinda in 1982 and the other at Kottegoda on 14 July 1983. The present record from Negombo is therefore the fourth so far reported.

It is of interest that the majority of *Peponocephala electra* have been taken in the month of October (1985, 1987 and 1988) even though these dolphins have been landed at different fishery harbours (Negombo, Beruwala, Mirissa and Kottegoda). We are unable to offer any explanation at present for this situation.

Alling (1985) attributes the mortality of dolphins in Sri Lanka mostly to entrapment in gillnets used by fishermen. However, out of a total of 26 animals discussed in the present paper 10 had been harpooned. That harpooning is a threat as serious as net entanglement is also suggested by the data we have obtained in respect of other dolphin species in the landed catch at these fishery harbours.

Mohan (1985) states that the peak season of the occurrence of dolphins in the nets in Calicut, India, is from October to February although there were individual variations between the species. The infrequent species discussed in this paper were landed in the months of January, February, April, May, July, September and October. However, the majority of the records are during the period from October to February. We hope to analyse the data obtained on the landed catch of other dolphin species in this study in due course and the results will shed more light on the exact situation in Sri Lanka.

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August 31, 1990

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4. THE FLAMINGO *PHOENICOPTERUS ROSEUS* PALLAS IN KERALA

Purathur, 55 km south of Kozhikode on the west coast of Kerala, is the point where the river Bharathapuzha enters the sea. The estuary is characterised by shallow waters and extensive sandy islets which get exposed during low tide. The river is approximately a kilometre wide towards its mouth. The birds seen at the estuary include some species rarely seen in Kerala.

During the winter months from October to March, large numbers of shorebirds and seabirds visit the estuary and many congregate on the sandflats. Purathur is one of the largest congregating sites for

gulls in Kerala.

On 11 March 1991, a flock of five flamingos *Phoenicopterus roseus* was found feeding in the shallow waters of the estuary. All the birds appeared to be immatures. They were all greyish with a little pink daubed on the back. The head and neck were greyish brown. In flight, the primaries and the trailing edges of the wings were black. The bill was sharply downcurved and black-tipped. The rest of the mandibles were horn coloured; and the legs, pinkish. The birds were standing in knee-deep water engaged in their characteristic feeding movements for sifting brine. They did not appear to be too wary of our approaching canoe but only walked away. Local enquiries indicated that the five birds had been there from about the middle of January.

D. K. NARAYANA KURUP
December 24, 1991 C. MOHAN KUMAR

5. A VISIT TO THE 'FLAMINGO CITY' IN THE GREAT RANN OF KUTCH, GUJARAT

In his excellent notes on the breeding of the flamingos *Phoenicopterus roseus* and *Phoeniconaias minor*, Dr. Salim Ali has fully described the conditions in the Great Rann, the rivers flowing into it etc. Without repeating the details, it may be mentioned here that conditions recently were similar to those described by him (*JBNHS 71 (1)*: 141-144, 1974). Since Salim Ali first described his visit in the year 1945 (*JBNHS 45*: 586-593) conditions in the Rann, particularly the water regime, have undergone a change. This is mainly owing to the damming of the rivers and rivulets flowing into the area. The inflow of water from river Luni (Rajasthan) and also from the Banas (N. Gujarat) is far less since dams have been built on them. In the beginning of the 1990 monsoon season extremely heavy rain fell in north Gujarat and in Barmer district of Rajasthan due to which the dams on those rivers overflowed, and continued to do so for a long time. Rain arrived late in Kutch (end August), but Pachham got very heavy rainfall, as a result of which plenty of water went into the Great Rann. Thus conditions for nest-building did not become suitable till about November 1990.

During my birdwatching trips in Kutch during the 1989-90 winter I noticed a near complete absence of the greater flamingo in their usual haunts, along the sea coast, in tidal creeks and on inland collections of water. This was also observed by other birdwatchers in this district. So it was suspected that these birds may have congregated in the Rann.

Thus to investigate whether the flamingo had actually collected in the Great Rann of Kutch it was necessary to pay a visit there. I was fortunate in succeeding to persuade the Forest Department of the district to undertake a survey. So along with A.C. Patel, Assistant Conservator of Forests, Bhuj, two Forest Guards and a Ranger, I set out for the well known 'Flamingo City' on 7 January 1991. Camels were locally hired at Tugga village to take us to Nir, a former outpost of the erstwhile Kutch State Police, now manned by the B.S.F., and the entry-point for the Rann in the north of Pachham Island. After about a 14 km journey we made a night halt at Nir. The winter morning of 8 January was very clear with good visibility. We could see flamingo at a distance as a thin white line from Nir itself.

The final stretch of about 8 km from Nir through the slush and water, from 60 cm to about 1.3 m deep, in the Rann took us nearly five hours with the camels wading through water and slithering in the slippery mud. We reached the 'Flamingo City' around 1430 hrs. We took a rough count of the birds with the help of binoculars. Our estimate was that there were 25,000 to 30,000 adults, between 10,000 and 15,000 young, ranging in age from newly hatched to a fortnight old and several nests containing one egg each. Our first impression was that there could not have been less than 12,000 nests, some of them perhaps unoccupied, while there may have been others left over from a previous year's breeding attempt. Actually the colony is in two sections with some clusters of nests having empty spaces in between, making the estimation of their numbers rather tricky; and this would also apply to the calculation of the number of the flamingo. Besides this, the haze caused by the afternoon sun adds to the difficulty. We had already spent about 2 $^1/_2$ hours there; not wanting to unduly disturb the breeding birds and we began our return journey to Nir. As we left, we could look back to see the adult flamingo starting to come back to their eggs and young.

Not having been satisfied with the rough

TABLE 1
NEST COUNTS IN ARBITRARILY DEMARCATED AREAS

Area	No. of nests	No. of eggs
6.5 x 20m	352	56
4 x 3 m	55	1
3 x 3.3 m	27	1
4 x 4 m	108	3
13.2 x 20 m	450	128
5 x 15m	186	36
16 x 16 m	436	208
5 x 8.2 m	207	58
Total	1821	491

counts, particularly of the nests, I paid a second visit to the flamingo colony on 30 January 1991. This time an attempt was made to take a sample count of the nests covering approximately one-sixth of the area of the colony. The area was roughly divided into sections, as shown in Table 1.

I did not take a count of chicks, for there were just a few in the nest, and those which could walk herded together and moved too far away, making it impossible to count them.

March 13, 1991. NAVIN N. BAPAT

6. BRAHMINY KITE *HALIASTUR INDUS* (BODDAERT) PREYING ON BATS

The brahminy kite *Haliastur indus* is mostly regarded as a scavenger, feeding chiefly on dead or dying fish. Its diet is reported to include crabs, frogs, small lizards, snakes, young or sickly birds, insects (mainly termites and grasshoppers) and mice. An attack on a hare is mentioned in HAND BOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali S. and Ripley, S.D. 1983.

We recorded a case of brahminy kite preying on bats at Vedaranyam, 11 km from the Point Calimere Wildlife and Bird Sanctuary in Tanjore district, Tamil Nadu. At Vedaranyam, an old dilapidated structure housing a chariot of the Vedaranyeshwar temple, harbours a huge colony of insectivorous bats. After sunset, there is a stream of bats flying out of the building. On 14 August 1990, we noticed a brahminy kite making circles and trying to catch bats without success. During our second visit a few days later, a brahminy kite was again unsuccessfully attempting to catch bats. At the same time we saw a shikra or sparrow hawk (?) (*Accipiter* sp.) catch a bat. On our third visit on 24 August 1990 we saw two brahminy kites hunting for bats, of which one was successful. On capture, it pecked at the shrieking victim to kill it and then flew to feed on a nearby coconut tree. These observations show that the brahminy kite is also an active predator of fast moving prey, and bats form part of its diet.

January 7, 1991 RANJIT MANAKADAN
V. NATARAJAN

7. SURGERY OF A RARE KIND

On 11 March 1990 two young Bonelli's eagles *Hieraaetus fasciatus* were found at Galavde wadi near Indapur, Maharashtra. One of them had a fracture on its left leg. Most probably this could have been due to the injury sustained by the bird when their nest was destroyed by local people. X-rays was taken and it was found that the tibiotarsus was fractured and there was one centimetre of overriding. If only plaster was used the eagle would have been left with a shortened and weak leg. As eagles kill their prey with their talons and strong legs are necessary it was decided to operate on the eagle's leg. The eagle was operated under local anaesthesia as this was found to be the safest. A lateral approach was taken and the bones were reduced and fixed with a plate and four screws. An intra medullary rod was put as an additional support. The screws and plate used were made of special American steel which does not react and is used in human finger operations.

It was noted that the tibiotarsus of the leg bones of a bird has a thin cortex. This is because the bones should be light in weight to facilitate flight. The medullary cavity is very broad. The bone is flat anterioposteriorly.

The muscles of the leg are extremely strong and are grouped in anterior and posterior groups to enable

the bird to push off from the ground while taking off, and buffer the shock while landing.

The healing of such a fracture in human beings would take three months. The exact healing period in a bird (assessed by subsequent X-rays) is not known.

As absolute anatomy had been restored and the fracture subsequently healed well, we expected that the eagle would recover to normal and could be released back in its environment subsequently. The eagle was kept under the care of Neelamkumar Khaire at the Snake Park Office, for three months and fed with mice daily. There after it was released.

This operation was done by me, assisted by Dr. Sunil Jakar, Atul Varekar and Jayant Deshpande.

April 9, 1990 SATTYASHEEL NAIK

8. RUFOUSBELLIED HAWK-EAGLE *HIERAAETUS KIENERII* (E. GEOFFROY) IN ANDHRA PRADESH

The Birdwatchers Society of Andhra Pradesh had organised a camp at Tirumala Hills, Tirupati from 24 to 28 August 1990. During this camp a rufousbellied hawk-eagle *Hieraaetus kienerii* was sighted on the morning of 25 August at Japali, 5 km from the town of Tirumala on the Tirumala-Tirupati road.

The rufousbellied hawk-eagle is about the size of a kite. There is a faint but distinct occipital crest. The head, crest, back, wings and upper tail are dark slaty black. The lower breast, belly and vent are rusty red while the upper breast and throat are white with black streaks. The red plumage also has black streaks mostly on the flanks and thighs. The undertail is silvery white with four faint black bands and one broad black terminal band. The tarsi are clothed in short bristles.

In overhead flight the secondaries and lower body are rusty red, the outer wing feathers (primaries) are black and there is a white band separating the black feathers from the red. The black terminal tail band is very suggestive of its identity as also the white throat and upper breast.

Ali and Ripley (COMPACT HANDBOOK OF BIRDS, 1987) gives the bird's status in south India as "...the Western Ghats strip in South India from Goa and N. Mysore through Kerala (up to *c* 1200 m). Absent in intervening country." Taher and Pittie (CHECKLIST OF THE BIRDS OF ANDHRA PRADESH, 1989) also do not mention this species as occurring in the state. In no other literature can I find reference of this bird as being found in Andhra Pradesh.

This then may result in a range extension of the species particularly if further sightings were to occur from this part or other parts of the state also. The habitat as mentioned in the HANDBOOK seems to tally with that on the Tirumala Hills where the bird was seen.

June 28, 1991 HUMAYUN TAHER

9. SOME OBSERVATIONS ON MAINTENANCE BEHAVIOUR OF THE REDWATTLED LAPWING *VANELLUS INDICUS* (BODDAERT)

(With eleven text-figures)

Introduction

This paper deals with some observations on maintenance behaviour of the redwattled lapwing *Vanellus indicus.* The term 'maintenance behaviour' as used in this paper includes movements associated with preening, bathing, cleaning, shaking, wing drying, stretching, resting and sleeping.

The study was carried out in Chandigarh (30° 42′ N, 76° 54′ E) and surrounding areas. All observations were made on wild birds using 12 x 50 prismatic binoculars and a portable blind (LeCroy 1975). The categorisation of various activities as maintenance behaviour is after Armstrong (1950), Dilger (1960), Mayerriecks (1960), Maxwell and Putnam (1968) and McAllister and Maxwell (1971).

Observations and Discussion

Preening: Preening was the most frequent maintenance activity observed in the redwattled lapwing during interludes between feeding, nest relief, after copulation and periods of resting. All regions of the body accessible to the beak were preened. The preening of breast (Fig.1), wing coverts

(Fig.2), abdominal, back and rump regions was done by nibbling, while primaries, secondaries and rectrices (Fig. 3) were stroked.

For preening the breast and belly regions, the head was turned towards the respective region. Preening of the wing was done from inside as well outside, for which the wing was slightly extended and the head bent backwards. For stroking the rectrices, the neck was turned backwards to one side, head tilted at an angle, tail was spread and turned on its axis to one side. In all preening activities the body was kept horizontal and the tail was not lowered, except during breast preening where the tail was lowered slightly. Horizontal body posture during preening is an adaptation in waders and ducks: lowering of wings or tail, thereby touching the muddy substrate, will lead to wet or dirty feathers and will probably damage the delicate tips of wings and tail (Ten Cate 1985). During the breeding season, copulation was always followed by tail and belly preening in males and tail preening in females. Preening movements in the chicks appeared 2-3 days after hatching. Due to poor coordination, young chicks usualy toppled over when they attempted to preen. Initially only the breast and outer wing regions were preened; preening developed gradually as the chicks grew older.

Preening helps in the care of plumage, removal of ectoparasites, and to rearrange the feathers that might get displaced during various activities. Other reported functions of preening are advertisement (Sodhi and Khera 1984) and courtship display (McKinney 1965, Edwards 1982). Preening as displacement activity has been reported in the breeding avocet *Recurvirostra avosetta,* little ringed plover *Charadrius dubius,* kentish plover *Charadrius alexandrinus* (Simmons 1961), common tern *Sterna hirundo* and sandwich tern *Sterna sandvicensis* (Iersel and Bol 1958).

Bathing: For bathing the redwattled lapwing waded into a shallow pool, sat in water, dipped its head and body alternately into water and performed body shaking movements.The wings were kept slightly elevated during bathing. On a few occasions, the birds were observed to perform breast preening during bathing.

Cleaning: Some cleaning movements observed are as follows: *Scratching*: The bird scratched its head, neck and beak by dropping one wing and bringing up the corresponding leg over to the region to be scratched (Fig. 4). This method of scratching has been termed indirect scratching (Simmons 1957, 1961; McFarland 1981). The head was rotated and turned for scratching different regions of head and beak. The scratching was usually associated with preening but could also be observed as an independent maintenance activity. McKinney (1965) observed that scratching serves to remove irritation caused by ectoparasites, loose feathers and clean. In the redwattled lapwing, scratching also helped to clean the bill. Chicks also scratched by indirect method. Although very young chicks could not bring up their leg over the shoulder for scratching, the wing was always lowered prior to scratching. The head scratching methods in birds have taxonomic significance and one method is used by all members of the same family (Simmons 1957). Simmons (1961) reported head scratching as displacement activity in the breeding avocets and little ringed plovers. The lowering of wing during indirect scratching may serve the bird to keep better balance either by lowering the centre of gravity (Simmons 1961) or by placing the wing bow on the perch as a support for the body (Ten Cate 1985).

Shoulder rubbing: During this activity, the bird turned its neck to one side and vigorously rubbed the lateral side of its head on the outer side of wings near the shoulder region (Fig. 5). The shoulder rubbing was observed as an independent activity as well as in association with preening and bathing. This movement probably served to clean the eye.

Shaking: The following shaking movements were observed: *Body shake:* The bird assumed a horizontal posture, loosened the wings and vigorously shook the body along the antero-posterior axis (Fig. 6). This was followed by one jerky rotating movement of the head. Body shake was observed after preening, bathing and copulation. Body shake helps to remove water drops from the feathers and to rearrange disordered feathers.

Wing shake: The redwattled lapwing withdrew its neck, loosened its wings and shook them with short vibrating motion. The wing shake was usually observed after preening of wings after bathing. This movement helped to dry and rearrange the wing feathers.

Head shake: The head and bill were shaken laterally by movements of the neck. Head shake occurred independently or in association with preening and after feeding. Chicks also performed head shake.

Fig. 1 Preening (Breast)

Fig. 4 Scratching

Fig. 2 Preening (Wing coverts)

Fig. 5 Shoulder rubbing

Fig. 3 Preening (Rectrices)

Fig. 6 Body shake

Figs. 1-6. Redwattled lapwing, showing postures during preening, resting etc.

Fig. 7 Wing and leg stretch

Fig. 9 Resting on one leg

Fig. 8 Both wings stretch

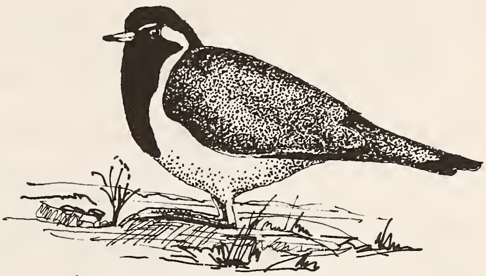

Fig. 10 Resting on tarsi

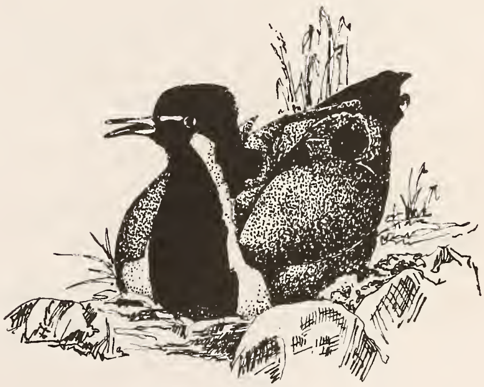

Fig. 11 Sitting

Figs. 7-11. Redwattled lapwing, showing postures during preening, resting etc.

Head shake removes water, dirt, food particles or loose feathers from the surface of bill (McKinney 1965).

Tail wag: In this movement the tail was shaken laterally a number of times. The rectrices were not fanned during this movement. In general tail wag was observed during preening, after copulation, defecation and bathing. McKinney (1965) observed that tail wag in male Anatidae probably helps to return the penis to its usual position in the cloacal cavity after copulation. Other functions of tail wag are – removal of water from the tail, rearrangement of misplaced rectrices and tail coverts and reinversion of cloacal lips after defecation.

Stretching: Wing and leg stretch, and both wings stretch were the two stretching movements observed. *Wing and leg stretch*: In this movement the bird withdrew the neck, shifted its weight on to one leg and extended the wing of the other side backwards (Fig. 7). The leg on the side of stretched wing was then extended beneath the wing. After stretching, the leg and wing were withdrawn simultaneously.

Both wings stretch: The bird while standing raised both wings upwards simultaneously (Fig.8).

Both types of stretching activities were performed after periods of rest. Stretching probably helps to stimulate the flow of blood in the limbs, thus preparing the muscles for further activity (Kortlandt 1940 in McKinney 1965).

Resting and sleeping: In all resting postures the neck was withdrawn. The birds rested while standing on both legs, on one leg (Fig. 9), on tarsi (Fig. 10) and sitting (Fig. 11). In one variant of resting in standing posture, the birds, while keeping the carpal joints bent and near the body, extended their primaries downwards. The primaries in this position never touched the ground. The eyes were closed in all the resting postures. Chicks both rested on tarsi and sitting, but closed their eyes in sitting posture only.

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R.S. KALSI
S. KHERA

April 9, 1991

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10. CASPIAN PLOVER *CHARADRIUS ASIATICUS* PALLAS AT PT. CALIMERE, TAMIL NADU

The Caspian plover *Charadrius asiaticus* has apparently only been recorded once within India's boundaries, a specimen having been collected near Ratnagiri, Maharashtra in 1880. There is one sight record from the Andaman Islands (SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, Ripley, S.D. 1982), which is now considered as a separate species, the Oriental plover *Charadrius veredus.*

On 18 February 1991 at about 1630 hrs K.J.K. sighted a Caspian plover in partial breeding plumage on the beach at the southern boundary of Pt. Calimere Wildlife Sanctuary, Tamil Nadu. Initially it was seen near the water's edge but soon moved to the adjoining area of dry sand, dotted with patches of dry grass. There it continued feeding for approximately half an hour in the company of two lesser sand plovers *Charadrius mongolus* and several Kentish plovers *Charadrius alexandrinus* which enabled useful comparisons to be made. The bird was seen again briefly at 1745 hrs on the grassland further inland, where it was loosely associated with some Pacific golden plovers *Pluvialis dominica fulva.*

K.J.K. informed S.B. and L.R. and the following morning they together relocated the bird, near where it had last been seen, and confirmed its identity. It was observed with a telescope at fairly close range for a period of 20 minutes while feeding with pacific golden plovers and little ringed plovers *Charadrius dubius.*

The following field characters were noted: The overall size appeared somewhat larger than that of lesser sand plover, perhaps due to the considerably longer legs, which were of a pale green colour. The upper parts were a uniform brown, concolorous with the rump and tail, which had no obvious white areas, although there may have been some white edging to the latter. The 'face' was very pale with white forehead, throat and lores being joined to a distinct broad white supercilium that curved back behind the eye, the lores and forehead having a slight chestnut buffy wash, which was also visible on the brown of the hind-neck. The thick brown eye-stripe extended back behind the eye to join the brown of the upper parts. The bill was noticeably different to that of lesser sand plover, being likewise black but tapered to a finer point. The most distinctive feature was the broad, pale chestnut band, a dark brown line and at close range showed some white scaling. Belly and undertail coverts were white. The bird was observed to have a white wing-bar, which together with its white axillaries and wing-lining separate it from the very similar Oriental plover.

HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983) does not record its behaviour in India. Our bird appeared to have a fairly typical plover-type feeding pattern with its rather upright stance resembling that of the Pacific golden plover.

This is an interesting sighting of a species that has not been recorded on the Indian mainland for over 100 years.

K.J. KAZMIERCZAK
S. BALACHANDRAN
LIMA ROSALIND
May 6, 1991

11. UNUSUAL BEHAVIOUR OR ADAPTATION AGAINST PREDATION IN TEREK SANDPIPER *TRINGA TEREK* (LATHAM)

On the morning of 2 April 1991 we observed a scattered flock of Terek sandpiper *Tringa terek* (Latham) (return migration flock) numbering 32, feeding in the reservoirs in the Great Vedaranyam Swamp at Pt. Calimere, Tamil Nadu. Five were caught by the trappers of the Bombay Natural History Society for ringing as part of the ongoing Bird Migration Project. The first two Terek sandpipers grouped together after release. The third was released along the water's edge. Suddenly a brahminy kite *Haliastur indus* stooped to catch it. But to our astonishment the sandpiper immediately dived into the water, surfaced about 60 cm away and swam for few seconds. Once again the brahminy kite tried to prey upon it, but the bird dived again into the water and came out about 1.54 m away and swam for another 1.25 m to reach the bank. In the meantime we got into the water and chased the brahminy kite away, which gave time for the sandpiper to hide itself under nearby *Suaeda* bush.

The swimming behaviour of terek sandpiper has been recorded (BIRDS OF THE WESTERN PALEARCTIC, Cramp and Simmons, K.E.L. 1983). But diving into water is an unusual behaviour not known to be recorded, which may be either an adaptation to escape from predators or may be an impulsive action resulting from panic.

May 8, 1991 S. BALACHANDRAN
V. NATARAJAN

12. UNUSUAL FORAGING SITE OF GOLDENBACKED WOODPECKER *DINOPIUM BENGHALENSE* (LINN.)

11 April 1991, at 0830 hrs while walking along the road near one of my study sites at Pt. Calimere Wildlife Sanctuary, Tamil Nadu, I saw a goldenbacked woodpecker *Dinopium benghalense* flying from the forest towards the swamp. I was puzzled to see a woodpecker flying towards the swamp, which was not its habitat, but it immediately perched on one of the concrete electric poles along the road. After landing on the lower part of the pole, it started creeping up in short spurts, inspecting and picking up some prey from the crevices. It picked prey from three crevices on the pole and once from the gap between the iron clamps at the top of the pole. Afterwards it flew to another pole, repeated similar foraging tactics at two crevices and flew towards the forest. Inspection of some crevices on these poles revealed the presence of beetles, ants, cockroaches and spiders.

According to Ali and Ripley (1983, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN), the woodpeckers pick up insects from tree trunks, boughs and the ground. This observation reports an unusual foraging site of the goldenbacked woodpecker.

June 10, 1991 S. ALAGAR RAJAN

13. A SILENT ASSOCIATION

On 12 January 1991 near Kakachi I happened to come across a small troop of liontailed Macaques *Macaca silenus* in the dense evergreen forest. The monkeys were seen probing the flowers of *Cullenia exarillata* and brought down a rain of flowers, twigs, bark and some insects. A little below the monkeys, I noticed a racket-tailed drongo *Dicrurus remifer* silently foraging under the 'rain'. The monkeys moved to another tree and were soon followed by the drongo. Such an association I have seen almost at all seasons at Kakachi.

The HANDBOOK OF BIRDS (Ali and Ripley, S.D. 1983) mentions the drongo associating closely with treepies and woodpeckers but monkeys are not mentioned. Elsewhere, however, birds have been seen associating with monkeys (Bonski and Scott, *Biotropica 20(2)*: 136-143, 1988).

March 13, 1991 T. GANESH

14. TREE PIE *DENDROCITTA VAGABUNDA* (LATHAM) FEEDING ON ARIL OF SEEDS OF *PITHECELLOBIUM DULCE*

On 26 April 1991, at Bundha Forest Nursery of Jamwa Ramgarh Range (Division Jaipur-West), I noticed a party of 13 individuals of the tree pie *Dendrocitta vagabunda* (Latham) feeding on arils of seeds of *Pithecellobium dulce* along with redvented bulbul *Pycnonotus cafer*, roseringed parakeet *Psittacula krameri* and other frugivorous birds. Some individual of treepie were picking up fallen green pods of *Pithecellobium dulce* from the ground while others were plucking them off the trees. Holding the pods in their claws, they were tearing the pods with their bills and devouring the arils, an outgrowth present on seeds.

The forest of the locality has a dry-deciduous type of vegetation and *Pithecellobium dulce* is an exotic component of these forests introduced by the Forest Department, a few local nurseries and plantations.

July 21, 1991 SATISH KUMAR SHARMA

15. CROWS FEEDING ON THE SEEDS OF *ALBIZIA LEBBECK* AND THE EXOTIC *ACACIA MELANOXYLON*

On 9 March 1990, in the Forest Rest House premises at Pt. Calimere, Tamil Nadu, we saw many house crows *Corvus splendens* Vieillot and a few jungle crows *Corvus macrorhynchos* Wagler feeding on the seeds of *Acacia melanoxylon*. During March, the pods of *Acacia melanoxylon* break open, exposing the seeds which are attached to the pods by the arils. A large number of crows were seen actively feeding on the seeds. We also saw a few golden orioles *Oriolus oriolus* feeding on these seeds. *A. melanoxylon* is an exotic introduced from Australia.

In another incident on 11 March 1990, at Thopputhurai (13 km from Pt. Calimere), many jungle crows and a few house crows were observed feeding on the seeds of *Albizia lebbeck*. The crow would clutch a plucked dry pod with its feet, break open the pod and eat only one or two seeds. The pod with the remaining seeds was discarded. The crows were seen to feed on these seeds for many days, as long as the pods were available. A few threestriped palm squirrels *Funambulus palmarum* were also noticed feeding on the seeds.

V. NATARAJAN
P. BALASUBARAMANIAN
Y. NAGESWARA RAO
S. ALAGAR RAJAN

June 15, 1991

16. FOOD-STORING BEHAVIOUR OF THE JUNGLE CROW *CORVUS MACRORHYNCHOS* WAGLER

On 3 September 1988 at the Forest Rest House at Pt. Calimere Wildlife and Bird Sanctuary, Tamil Nadu, I saw a jungle crow *Corvus macrorhynchos* flying with a piece of fish in its bill. Later, the crow placed the fish on the ground and then covered it with leaves of *Thespesia populnea* and flew away. I noticed similar storage behaviour of this crow on many occasions during the fishing season, when a lot of fish waste is available. Food storage during abundance of food is reported in crested tit *Parus cristatus* (Haftorn 1953), acorn woodpecker *Melanerpes formicivorus* (Bent 1939), jays *Garrulus glandarius* (Chettleburgh 1952), ravens *Corvus corax* (Gwinner 1965), nut cracker *Nucifraga caryocatactes* (Swanberg 1951). Food storing behaviour of the jungle crow is worth mentioning as it has not been reported earlier.

June 20, 1991

V. NATARAJAN

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17. SIGHTING OF WHITEBELLIED MINIVET *PERICROCOTUS ERYTHROPYGIUS* (JERDON) AT BANDIPUR

While watching birds at the Bandipur Tiger Reserve on the morning of 22 August 1987 a pair of whitebellied minivets *Pericrocotus erythropygius* (Jerdon) were seen. The birds were in an open patch with a few scattered bushes very close to a waterhole east of the reception centre. The birds were first

spotted while they were perching on a dry bush about 60 cm from the ground and later flew to a nearby tree. Subsequently on the morning of 23 August 1987 a pair of this species was seen in the same area.

The whitebellied minivet is known to occur south up to Belgaum and also the base of the Nilgiris (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1987). Salim Ali during his 'Birds of Mysore' survey (1939) did not come across this species. The present sighting is the southernmost for Karnataka and probably also the first report of this species between Belgaum and the Nilgiris.

March 13, 1991 S. KARTHIKEYAN

18. SPOTTED LONGTAILED WREN-BABBLER *SPELAEORNIS TROGLODYTOIDES* (VERREAUX) IN ARUNACHAL PRADESH

According to the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983) the spotted longtailed on when-babbler is rare resident and has been reweded only in eastern Bhutan. I sighted on 27 April 1991 more than four of the above birds in a mixed party of brownheaded tit-babbler *Alcippega cinereiceps* and yellowbacked sunbird *Aethopy nipalensis*. This sighting was done in a scrub/rhododendron forest at an altitude of 2800 m at 0930 hrs near Chaku in Eagle Nest Wild-life Sanctuary, Arunachal Pradesh. It is along an elephant track to the nearby hill peak (2940 m altitude) and about 5 km north of Chaku, the grid reference being 825392 (Toposheet 83 A/8).

Eagle Nest Sanctuary falls in west Arunachal Pradesh in West Kameng district. The area is very close to East Bhutan where the bird has been recorded.

July 7, 1991 PRATAP SINGH

19. LEAPFROGGING IN COMMON BABBLERS *TURDOIDES CAUDATUS CAUDATUS* (DUMONT)

The general habits of common babblers have been described in 'HAND BOOK OF BIRDS OF INDIA AND PAKISTAN' (Ali S. and Ripley S.D. 1983) as, the species keep in flocks of six to twenty individuals sometimes even in the breeding season, spending its time on the ground, hopping about rapidly with a bouncing gait, more commonly and scuttling like a rat under the sparse vegetation and hedges.

On 8 May 1990, around 1730 hrs a flock of eight birds was noticed indulging in a typical behaviour termed as 'leapfrogging'. A flock appeared on a parapet wall and started probing for insects. Movement of the flock was accomplished by the rear bird jumping forward, over the next bird, and landing about 15-25 cm ahead and so on. This way the flock traversed a distance of about 6.5 m on the wall and another 5 m on the next wall, pausing intermittently to probe for insects and feeding thereon.

Leapfrogging in cattle egrets has been recorded (*JBNHS 83 (2)*: 432, Paul Newton) but its adoption by common babblers has not been mentioned in the available literature.

July 9, 1991 A.M.K. BHAROS

20. KASHMIR REDBREASTED FLYCATCHER *MUSCICAPA SUBRUBRA* HARTERT AND STEINBACHER AT OOTY

While watching birds at the edge of a *shola* close to Radio Astronomy Centre, Ooty[1], on 11 December 1990 one of us (SK) spotted a flycatcher very similar in habits to the redbreasted flycatcher *Muscicapa parva* but with extensive red on the breast edged with black.

The bird was sighted in a wattle plantation bordering the *shola* and it never flew above one and a half metres from the ground. Using the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1987, 2nd Compact ed.) the bird was later identified as the Kashmir redbreasted flycatcher *Muscicapa subrubra* Hartert and Steinbacher. The

[1]For earlier record from Ooty, see S.C. Harrap & N.J. Redmann, 1989, *JBNHS 86(3):* 460-61—Editors.

identity of the bird was later confirmed by examining a museum skin of the species at BNHS by one of us (VRA).

The Kashmir redbreasted flycatcher is known to breed in Kashmir and winter in Sri Lanka. Hitherto it has been reported only from North India and Secunderabad on passage in both directions (Compact HANDBOOK). As the sighting of the species has been in December, it could have been wintering in this area, as it has been recorded on passage only during the months of September, October and later in March and April.

S. KARTHIKEYAN
May 28, 1991 VIDYA R. ATHREYA

21. SOUTHERN ASHY WREN–WARBLER *PRINIA SOCIALIS SOCIALIS* SYKES IN PT. CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

The status of the southern ashy wren-warbler *Prinia socialis socialis* had been stated by Ali and Ripley (1983, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN) as a locally common, resident species. It is distributed unevenly in the entire peninsula south of the Narmada river and southern Bihar. At Pt. Calimere Wildlife Sanctuary, Tamil Nadu, there is no resident warbler species except for the tailor bird *Orthotomus sutorius*. The ashy wren-warbler is only the second resident warbler species from the Sanctuary. Though this species was recorded from the nearby Vedaranyam town (just 6 km away from the Sanctuary) on the north, and to the west in the Muthupet Reserve Forest (about 30 km away), it was not recorded during the 12 year study on the avifauna of the Sanctuary. A pair of the species was first sighted on 4 February 1991 in a small isolated patch of scrub jungle along the coast. A total of six birds were caught and ringed in the same month, of which three were juveniles. The record of this species is an addition to the avifauna of the Pt. Calimere Wildlife Sanctuary.

S. BALACHANDRAN
June 6, 1991 LIMA ROSALIND

22. SIGHTING OF AN INDIAN BLUE CHAT *ERITHACUS BRUNNEUS* (HODGSON) AT RAIPUR, MADHYA PRADESH

On 13 April 1991 an Indian blue chat *Erithacus brunneus* (Hodgson) was seen probing amongst dense bushes in our garden in Raipur, Chhattisgarh region of Madhya Pradesh. The bird was there the following day. There are no earlier records of this chat from Madhya Pradesh and these sightings thus form an addition to the bird list of the state.

September 18, 1991 AJIT BHAROS

23. DEW BATHING BY PURPLERUMPED SUNBIRD *NECTARINIA ZEYLONICA* (LINN.)

During the first week of April 1991, a pair of purplerumped sunbirds *Nectarinia zeylonica* regularly visited our office backyard at Vedaranyam to dew bathe on a banana tree *Musa paradisiaca*. Early morning, the birds would one by one slide over the wet leaf surface and have their 'bath'. They repeated this behaviour three or four times. After the bath they went to a nearby *Moringa oleifera* tree where they ruffled their feathers and preened. Breger (1967, 1968, 1972) described the dew bathing behaviour in several species of *Empidonax* flycatchers and Kirtland's warbler *Dendroica kirtlandii*. Verbeek (1962) reported dew bathing by the blackcapped chickadee *Parus atricapillus*, goldencrowned kinglet *Regulus satrapa*, red-eyed (MZ) Vireo *Vireo olivaceus*, song sparrow *Zonotrichia melodia*, and three species of wood-warblers. The observation on dew bathing in the purplerumped sunbird is an interesting record.

V. NATARAJAN
June 26, 1991 P. BALASUBRAMANIAN

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24. HOUSE SPARROW *PASSER DOMESTICUS* (LINNAEUS) FEEDING ON MOSQUITO LARVAE

I witnessed a house sparrow Passer domesticus feeding on mosquito larvae at Coimbatore, Tamil Nadu. Mosquitoes had bred in an abandoned, rain-water-filled mortar, used for 'wet' grinding of grains and cereals. The sparrow, a cock, would repeatedly fly to the mortar and peck at the larvae massing at the rim of the mortar. The reason for flying away after each feed was probably to allow the disturbed larvae to surface and regroup once again, making them an easier 'mouthful' of prey for the sparrow. Mosquito larvae are not listed as a food item of the house sparrow.

July 8, 1991 RANJIT MANAKADAN

25. SIND JUNGLE SPARROW *PASSER PYRRHONOTUS* BLYTH IN NORTH-WEST GUJARAT

While birdwatching at the Khari Nadi, c. 3 km west of Bhuj (Kutch), I saw three male and two female Sind jungle sparrows *Passer pyrrhonotus* Blyth on 22 January 1990 and again on the following day. Again I saw three males and one female on 4 August. they were seen in a mixed flock of house sparrows *Passer domesticus* and weaver birds. However, the last time I saw them they were in good colouration and appeared smaller than house sparrows, so I was more sure about the identification.

November 5, 1990 N.N. BAPAT

26. NESTING BY *PLOCEUS PHILIPPINUS* (LINN.) IN CLUMPS OF *SACCHARUM BENGALENSE* RETZ.

The common baya *Ploceus philippinus* is a species which generally does not favour grassy vegetation for hanging its nest. Abdulali and Ambedkar [1984, *JBNHS 81(3)*: 701-703] have reported this species nesting in a patch of grass *(Coix lachryma-jobi)* in Thana district, Maharashtra.

Since 1988, an all Rajasthan survey was conducted by me to list the host plants preferred by the three species of weaver birds, viz. *Ploceus philippinus, P. benghalensis* and *P. manyar.* During the survey, in the month of August 1989, four yearling cocks of *Ploceus philippinus* were noticed making their 'practice nests' in clumps of *Saccharum bengalense* Retz. near village Shyopur in Alwar district. More than a dozen immature males had hung their nests on *Acacia nilotica* close to the patch of *Saccharum.*

All the half built nests present on the *Saccharum* clump contained the usual blobs of mud at the potential points of the egg-chamber of the respective nests. This species rarely appears to nest in reeds. Nowhere in the locality were mature cocks observed nesting in reeds.

February 28,1991 SATISH K. SHARMA

27. BIRD AND BAT COLLISIONS WITH AIRCRAFT IN INDIA AT NIGHT

The BNHS has been receiving data on bird strike incidents as well as bird remains since 1966 from aerodromes all over India for identification of species involved. 67 species of birds and three species of bats are known to have struck aircraft in India (Satheesan *et al.* 1992). Of the total 420 confirmed bird and bat strikes to aviation in India 10.5% occurred during night time. An analysis of nocturnal bird-strike incidents based on bird remnants received by BNHS from military and civil aerodromes in India is given here.

Out of 44 nocturnal bird-strike incidents recorded (Table 1), the maximum were caused by the redwattled lapwing (25%) followed by stone curlew and bats (18.2% each). Of the 20 species mentioned in Table 1 the spotted dove is a diurnal bird and hence the incident might have occurred while the roosting bird was disturbed by the sound of the low-flying aircraft. The cattle egret, also a diurnal bird, was struck down around 1930 hours in the month of September, probably when the bird was flying late to roost.

Mid-air collision was caused by migratory birds in two incidents at Halwara (Punjab) where the common teal was involved and in one incident near Goa involving a Kashmir roller (Satheesan 1990). Ducks and waders are known to feed at night. During migration or while commuting to and from distant nocturnal feeding sites ducks and waders are likely to collide with aircraft.

Insects gathered around strong lights in an aerodrome area, especially on the runways, and

TABLE 1

NOCTURNAL BIRD AND BAT-AIRCRAFT-STRIKE INCIDENTS BETWEEN 1966 AND DECEMBER 1990 (N = 44)

Bird/Bat species	Weight in g	No. of incidents	Locality
Birds			
Cattle egret *Bubulcus ibis*	450	1	Ambala
Night heron *Nycticorax nycticorax*	275	1	Dundigal
Bittern *Botaurus stellaris*	900	1	Adampur
Common teal *Anas crecca*	300	2	Halwara
Black partridge *Francolinus francolinus*	400	1	Ambala
Rain quail *Coturnix coromandelica*	75	2	Hakimpet, Pune
Stone curlew *Burhinus oedicnemus*	380	8	Bareilly, Bhuj, Jodhpur, Gorakhpur, Bombay, Gwalior, Sirsa & Bidar
Small Indian pratincole *Glareola lactea*	40	1	Pathankot
Painted snipe *Rostratula bengalensis*	125	1	Bombay
Redwattled lapwing *Vanellus indicus*	190	11	Bareilly, Chandigarh (2), Kalaikunda, Dabolim(3), Bhatinda(3), Halwara
Sooty tern *Sterna fuscata*	200	1	Pune
Spotted dove *Streptopelia chinensis*	125	1	Hakimpet
Spotted owlet *Athene brama*	125	1	Dabolim (Goa)
Barn owl *Tyto alba*	300	1	Jodhpur
European nightjar *Caprimulgus europaeus*	75–100	1	Bhuj
Indian little nightjar *Caprimulgus asiaticus*	46	1	Bareilly
Kashmir roller *Coracias garrulus*	170	1	Goa (over sea)
Bats			
Pipistrelle bat *Pipistrellus mimus*	20	2	Halwara, Jodhpur
Tomb bat *Taphozous* sp.	25	1	Pune
Giant fruit bat *Pteropus giganteus*	600	2	Baroda/ Bombay Dabolim (Goa)
Unidentified microchiropteran bat	Not known	2	Hakimpet
Unidentified bat	not known	1	Dabolim (Goa)

taxiways including floodlights attract birds directly and indirectly (Ali and Grubh 1981, 1984). It is most likely that predominantly ground birds like stone curlew, redwattled lapwing, painted snipe, rain quail, black partridge and night heron frequent the runway for insects or insectivorous vertebrates that are attracted towards lights in the aerodrome area. Owls, nightjars and bats are nocturnal in their habits and are known to hunt for prey during night time in aerodrome areas and hence are hazardous to aircraft mainly at night.

Out of the 22 nocturnal bird and bat strikes to aircraft where altitude of incident is known, 50% occurred at ground level and the rest at different altitudes, the highest recorded being 2424 m. Nocturnal bird and bat strikes have caused significant damage to aircraft engines (ten times), windshield (twice) and even to nose cone, landing gear and landing lights (once each).

This data was collected as a part of the work of the BNHS bird hazard research programme being funded since 1980 by Aeronautics R & D Board, Defence Ministry, Government of India under its Operational Problems Panel.

S.M. SATHEESAN
ROBERT B. GRUBH
April 3, 1991

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28. RECORDS OF THE GHARIAL *GAVIALIS GANGETICUS* (GMELIN) FROM THE DHAKUAKHANA AREA OF ASSAM

(With a text-figure)

Dhakuakhana is a sub-division of Lakhimpur district in the far eastern part of Assam. The subdivision is entirely on the flood-plain zone of the Brahmaputra and the major tributary, the Subansiri. A large number of smaller rivers and channels crisscross the sub-division, making it a rich area for riverine fauna (Fig. 1). During a stay of about one and a half years (November 1989 to April 1991) I collected data on the occurrence of the gharial *Gavialis gangeticus*, some of which are very recent. These are presented chronologically.

1950: A major earthquake shook the whole of north-east India. The Subansiri river was blocked for four days by a heavy landslide upstream, resulting in drying up of many channels downstream. The villagers of Oyengia killed one gharial and also two mugger *Crocodylus palustris* on the river bed.

1953-54: One seen in the Rotua river. It was feeding on a large borali fish (*Wallago attu*). The local villagers saw the gharial tossing up the fish while eating.

1960: Gharials not uncommon in the Korha river near Samporamukh.

1974: A boy was attacked and injured by a gharial on the Chela river near Baghchuk. Up to 1973, sighting of 3-4 of these reptiles basking on the banks of the Chela river was not uncommon.

1975 (mid 1970s): One large gharial suddenly appeared in the Charikaria river near Dhakuakhana proper, creating panic among the bathers and fishermen. It was shot by a local hunter. Its length was about 6 m

1982-83: A gharial reportedly seen by the Mishing tribal people near Matmora on the Brahmaputra river.

1986: (a) One seen near Tekeliphuta in the Kherkotia suti (channel) just near its junction with the Brahamaputra. (b) One villager was injured when a gharial attacked him in the Chela river near Chelajan Kachari village.

1986-87: One seen in the Korha river near its confluence with the Charikaria river. The locals who saw it chased it downstream through the Chela river to the Kherkotia suti. Ultimately the Mishing tribals

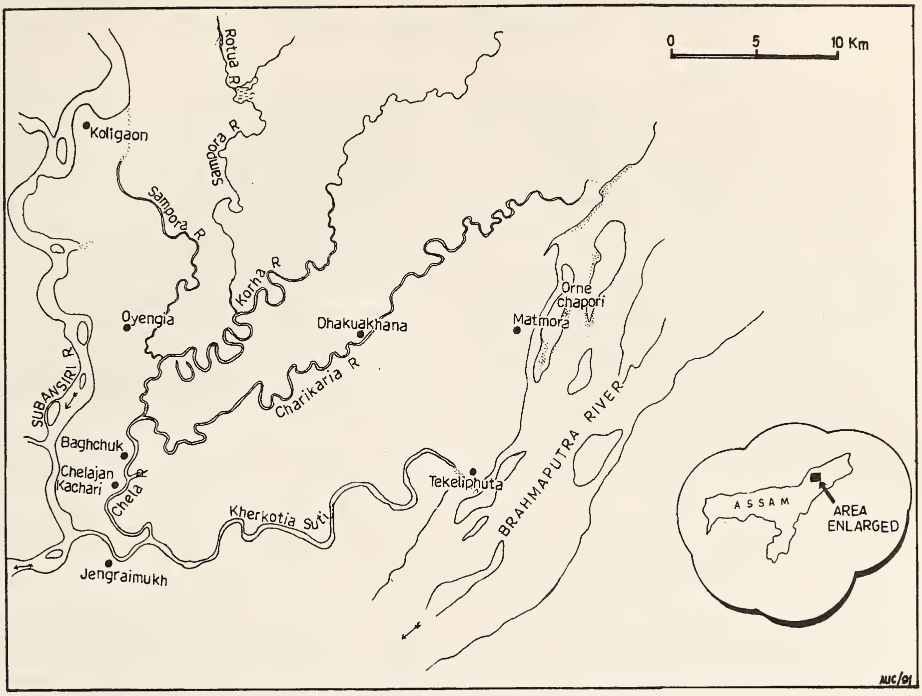

Fig. 1. Records of gharial from Dhakuakhana area.

killed it near Jengraimukh. It was about 4 m long.

1987: One seen in the Rotua river by the local villagers. It was about 3-4 m long.

1988: One near Tekeliphuta in the Brahmaputra; it was about 2.5 m long.

1989: One seen by the villagers of Koligaon on the Subansiri river during the floods.

The main reasons for decline of the gharial in the area are, (1) Use of *bheta* across the smaller rivers like the Korha, Charikoria and Chela (average width 80-90 m). *Bheta* is a type of temporary bund made of bamboo and is put accross the rivers to stop movement of fish. This ultimately prevents the gharial and even the Gangetic dolphin *(Platanista gangetica)* coming upstream; (2) Heavy year-round use of the rivers for fishing, bathing and washing (all the known and potential basking sites have been occupied by humans for various activities including setting up of fishing camps; and (3) Chasing and killing of any gharial sighted. While there are possibilities of gharial still living in the larger Brahmaputra and Subansiri rivers they are unlikely to be seen in the other rivers.

During my stay I prepared and submitted to the Government a proposal for a sanctuary, namely the Orne Chapori Wildlife Sanctuary (15 sq. km), which could provide a much needed refuge for the gharial in this stretch of the Brahmaputra river. The proposed area covers some islets with wide sand banks and water area of the Brahmaputra near Matmora.

February 2, 1992 A. CHOUDHURY

29. RANGE EXTENSION OF THE STRIPED GRASS SKINK *MABUYA DISSIMILIS* (HALLOWELL, 1857)

On 28 August 1991 at 1500 hrs a skink was observed foraging in dry leaf litter under bushes at Popero village of Limkheda taluka, Panchmahal district, Gujarat. It was yellow with prominent stripes on the body. We caught it after some 30 minutes of hard and careful search. On examination it was confirmed to be a striped grass skink *Mabuya dissimilis.*

Description: Total body length 20.3 cm; snout to vent length 7.5 cm; tail length 12.8 cm; shining yellow body colour with four less distinct dark brown parallel stripes, two on the dorsolateral side and two dark black coloured discontinuous stripes on the mid-dorsal region. Eyelid with transparent disk. 38 rows of scales on the body with tricarinate scales. Seven supra labials, the fifth being longer than the others, 16 lamella on the fourth toe.

According to Smith (FAUNA OF BRIT. INDIA, 1935) *M. dissimilis* is distributed in Rajasthan, Punjab, Bihar, West Bengal and Madhya Pradesh only. Other than that, distributional records of this skink are not available from the literature. The range of *M. dissimilis* is now extended to Pipero village of Panchmahal district, Gujarat. The collection site is very near to Madhya Pradesh; and near their border, both states have similar habitat. It is also presumed that this species occurs in the desert of Kutch on the Gujarat-Rajasthan border where ecological conditions are similar.

RAJU VYAS
B.H. PATEL

February 12, 1992

30. REVIEW OF DISTRIBUTION OF CONDANAROUS SANDSNAKE *PSAMMOPHIS CONDANARUS* (MERREM)

Recent publications on Indian snakes (Daniel 1983, Murthy 1986, Whitaker 1978) do not list the condanarous sandsnake *Psammophis condanarus* (Merrem) (Fam. Colubridae) as being reported from Karnataka erstwhile Mysore state). This is erroneous.

Whitaker (1978) mentions the distribution of *P. condanarus* as "western Himalayas and north-central India" while T.S.N. Murthy (1986) records its distribution as "occurs in Gujarat, Punjab, Uttar Pradesh, Maharashtra, Bihar, Bengal and Orissa". Daniel (1983) notes it as occurring in "peninsular India up to Bengal in the east and Andhra Pradesh in the south."

Salim Ali, during his survey of birds in Mysore state (present Karnataka), had retrieved a nine inch long *P. condanarus* specimen along with some loose snake scales from the stomach of a female short-toed eagle *Circaetus gallicus* (Gmelin) on 23 November 1939 at Gopala Swamy Betta (11° 35′ N; 76° 43′ E, 1451 m above msl) in Bandipur National Park, Karnataka (Ali 1943). Further, Ali mentions "strangely enough this is the first record of this snake from Mysore State" (Ali 1943, Ali and Ripley 1987).

Ali and Ripley (1987) record that the short-toed eagle's habitat preference is open cultivated plains, stony deciduous scrub, foothills and semi-desert, which is the same as the habitat preferred by *P. condanarus.*

Interestingly *P. condanarus* was not seen during the herpetofaunal Survey of Bandipur National park by Malhotra and Sahi (1982). Salim Ali's record happens to be the southernmost record for the species and also the only report from Karnataka. Hence, we may redefine the distribution of *P. condanarus* to include Karnataka.

February 12, 1992

J.N. PRASAD

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31. FIRST RECORD OF THE SUNBEAM SNAKE *XENOPELTIS UNICOLOR* REINWARDT, 1827 (SERPENTES: XENOPELTIDAE) FROM GREAT NICOBAR ISLAND

The sunbeam snake or iridescent Earth snake *Xenopeltis unicolor* is the sole representative of the family Xenopeltidae. It derives its name from the iridescence of its smooth scales. This species is distributed over south India, Burma, Indo-China, the Malay Peninsula and Archipelago (Boulenger 1893). Recently a new species *Xenopeltis hainanensis* found in the southern People's Republic of China has been described (Mehrtens 1987).

Specimens have been recorded from the Andaman Islands by Theobald (1868) and are found in the reptilia collection of the Zoological Survey of India (Biswas and Sanyal 1980). This is the first record of this species from the Nicobar Islands. The specimen was collected, and later released, by a 'Ranchi' tribal on Great Nicobar Island. Locally it is called 'tael-sap'.

Xenopeltis is the single genus of the family Xenopeltidae and has several unique characters. In addition to the occipital shield and loss of the postfrontal bone, the auditory bones are different from any other snake, except *Cylindrophis rufus* (Smith 1943).

The species has the following characteristics: snout rounded; head depressed and not distinct from the neck; eyes small with vertically elliptic pupils; nostril between two small nasals; interparietal about as large as the parietals; loreal absent; large preocular and two large postoculars; small supraoculars; numerous small, equal teeth; mental groove present; eight upper labials, first in contact with the internasal, fourth and fifth touching the eye; a pair of small chin shields, in contact with the three anterior lower labials; body cylindrical and covered with smooth scales in 15 rows; ventrals (173-196) well developed (Boulenger (1893) reports a ventral count of 166-193 in this species); tail short and subcaudals (24-31) in two rows (Smith 1943). The snake varies from black to brown in colour, with a whitish-grey venter.

A nocturnal animal, it burrows into the earth and is generally found in rice fields, lowland river valleys, and places with damp soil. It is a harmless snake, feeding on small mammals, frogs, snakes and birds, and has not been known to bite when handled. When excited it vibrates its tail vigorously. It is oviparous, laying about 18 eggs in a clutch. Large adults grow up to a metre in length; the average size is somewhat less. Very little of its biology is known.

The following morphological data was collected for the specimen found on Great Nicobar Island:

Total length: 51.1 cm; Snout-vent: 46.3 cm, Head-width (jaws): 12.55 mm, Upper labials : 8, Lower labials: 10, Mid body count: 15, Ventrals: 171, Subcaudals: 24.

I thank John for finding this snake and bringing it to me alive.

June 4, 1992

MANJULA TIWARI

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32. STRANGE BEHAVIOUR OF A MURREL *CHANNA STRIATUS* (BL.)

On 1 March 1991 at about 0830 hrs I, along with two friends, was walking along the shallow shore of the lake, watching aquatic birds. Near the shore we came across a small, discarded wooden boat, partly submerged in the lake. All the sides of the boat were above the water but inside there was

water up to about three fourths the length of the boat.

As we approached the boat a fish jumped out from inside the boat and landed in the lake. I examined the boat for other fish but there were none inside. The stagnant water inside the boat was full of small larvae, probably of mosquitoes.

We retreated about 20 m from the boat to find out what kind of fish it was and how it had entered the boat. Within seven minutes a fish broke water and landed inside the boat. When I tried to approach the boat close enough to watch the fish, it again jumped from the boat and escaped into the lake. This was repeated five times. I could make out that it was a murrel, but could not identify the species.

After some time we saw a boat with fishermen. We hailed them and requested them to catch this fish. When the murrel returned to the boat, one of the fishermen threw a net over the boat and caught the fish by hand. It was identified as *Channa striatus*.

After that we dragged the boat out of the water and found that, except for two small holes of about 3 x 2 cm, the entire bottom was intact. How the murrel came to know that there was water inside that boat with plenty of food in the shape of larvae is a mystery to me.

February 15,1992 RAZA TEHSIN

33. RECENT OBSERVATIONS ON THE LONGEVITY OF *MEGALOPS CYPRINOIDES* (BROUSS.)

In my previous note in the Society's *Journal* (Kulkarni 1983), I had mentioned different reports about longevity of certain fishes. These contained some anecdotes and indirect deductions also. Even Lagler *et al.* (1977) merely mention "authenticated records of ages of captive fishes suggest that ages of most venerated old carp do not exceed 50 years." The present note extends the limit to 52 years.

In the earlier note I had given a dependable record of the longevity of the Indian tarpon *Megalops cyprinoides* (Brouss.) being not less than 44 years in the fresh water of Walwan lake at Lonavla, dist. Pune (Maharashtra). After the study of breeding biology of the mahseer fish commenced in the above lake (Kulkarni 1971), every year in the months of July and August, when a particular section of the lake (which the fish appeared to prefer) was netted for the collection of ripe mahseer specimens for their artificial fecundation, a few individuals of *Megalops* were entangled accidentally in the nets, indicating that they had continued to survive there. Not much notice was taken of this occurrence. However, since 1983, I had kept a close watch on the survival of this species in the lake. In the note I had recounted how this marine or partly estuarine fish happened to be found in the fresh waters of the lake. Fingerlings of *Megalops* were introduced into the lake as a cyclopscidal fish for control of guinea worm pest (Setna and Kulkarni 1940) and also as a good sport fish, by Fisheries Section of the then Bombay Presidency in July 1939 (vide Annual Report of the Dept. of Industries,1939-40).

During one of the aforesaid type of fishing operations on 11 August 1991 a specimen of the above species was caught and measured for its length and weight. This marine fish spends only a short period (four to five months) in estuarine waters and then returns to the sea; it is not known to breed in fresh waters; neither smaller specimens nor fingerlings were ever captured during the past 20 years. It was thus clear that the specimen caught on that day belonged to the batch of fingerlings released in 1939. Moreover, there was no fresh stocking of *Megalops* after that year which I know quite definitely, being in charge of the Dept. of Fisheries till October 1969. These facts indicate that the fish could be at least 52 years of age (two years more than what Lagler *et al.* 1977 reported).

Surprisingly enough the fish had grown very little during the past twenty years. In 1970, some individuals were recorded to be 65 cm in length and 2.8 kg. in weight (Kulkarni 1983) while those caught in 1983 were 67 cm in length and weighed between 2.75 and 3.1 kg. This stagnation in growth was further confirmed by the specimen caught in August 1991, being only 67 cm in length and 3 kg in weight. This shows that after a certain growth in fresh water the fish just survives without gaining weight or length. The stagnation could not be due to lack of food because the lake had an abundance of aquatic life on which the *Megalops* normally feed, but could be due to having reached its normal maximum size. The F.A.O. identification sheet mentions only 55 cm as maximum length. Incidentally, the above observations provide a slightly improved record of growth of the fish.

July 2, 1992 C.V. KULKARNI

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34. ON DISTRIBUTION OF SPOT SWORDTAIL BUTTERLY *PATHYSA NOMIUS NOMIUS* ESPER

In the month of July 1987 we observed the spot swordtail butterfly *Pathysa nomius nomius* Esper in Jaipur city. We were on a survey of the rhopaloceran fauna of Jaipur city and in the process found this species in the nursery of the University of Rajasthan. Though the global distribution range of this butterfly covers the entire Oriental region, its occurrence still surprised us as none of the earlier workers have reported its occurrence in this particular region. According to Talbot (THE FAUNA OF BRITISH INDIA: BUTTERFLIES, 1939) and Evans (THE IDENTIFICATION OF INDIAN BUTTERFLIES, 1927) the distribution range of the spot swordtail is – Sikkim, Sri Lanka and south India. Both Talbot and Evans give a 'not rare' status to this butterfly. A wider distribution range (peninsular India to Bihar, Madhya Pradesh, Saurashtra, Lucknow, Simla to Sikkim, Assam, Burma and Ceylon) is reported by Wynter-Blyth (BUTTERFLIES OF THE INDIAN REGION, 1957) but that too does not include Jaipur or any other district of Rajasthan.

Wynter-Blyth's work also gives a 'not rare' status for this butterfly.

This butterfly was observed in many other localities in the same year (1987) but the maximum density was recorded in the above mentioned nursery. The other localities where swordtails were observed include certain busy roads, the garden of one of us (D.D.), and a few public gardens.

The spot swordtail butterfly is known to migrate long distances and to fly at altitudes as high as 2000 + m. It is quite possible that these butterflies observed in Jaipur were on their migratory route and were resting. There are certain facts which support this migration (irregular?) hypothesis. These are:

(a) All the swordtails disappeared after 15 August 1987.

(b) The reported food plants of this butterfly are *Saccopetalum tomentosum* and *Polyalthia longifolia*. Of these two, the latter occurs in Jaipur. No larvae of the swordtails could be found on *Polyalthia* plants.

(c) We again failed to find the spot swordtail during the next rainy season (July-August 1988) in all the localities where they were observed in the previous year.

DHIRENDRA DEVARSHI
M.M. TRIGUNAYAT

September 7, 1991

35. RECORD OF *PLEBEJUS EVERSMANNI* (STGR.) (LYCAENIDAE: LEPIDOPTERA) FROM INDIA

Malari lies in the dry, trans-Himalayan zone of Chamoli district in northern Uttar Pradesh (30° 41′ N, 79° 54′ E), at an elevation of *c.* 3000 m.

On 21 August 1987, a collection of butterflies was made along the motor road a kilometre north-east of Malari. A single male specimen of an unusual Lycaenid was recorded at a mud puddle gathering of Lycaenids, mainly *Polyommatus* Latreille. This was forwarded to the Rev. Alan Bean at the Oxford University Museum for identification. Unfortunately, the genitalia was damaged in preparation, so it is not diagnostic.

His observations on the specimen are as follows: "Forewing expanse: 12 mm. The aedeagus shows alulae. The labides are long, straight and terminally hooked. The falces are about the same length. The valvae were damaged."

"There is no spine on the upper side of the

foreleg tarsus, the presence of which is diagnostic for the genus *Plebejus* Kluk. The forelegs have been detached and are mounted on a card beneath the specimen."

However,, the specimen is identical in other respects to a series in the British Museum (Natural History), London. The series has been taken from two locations, "Tibet, Ta Tsien Lou, ex. coll. Oberthur, 1900" and "Yaregong, 1903", with a forewing expanse of 12-13 mm and identified as *Plebejus eversmanni* (Stgr.). I would suggest that the foreleg spine of the Malari specimen may have broken off at some stage and that it is of the same species as the *Plebejus eversmanni* (Stgr.) series in the British Museum (N.H.). The specimen from Malari did not match any other *Plebejus* Kluk at the British Museum (N.H).

Lewis (BUTTERFLIES OF THE WORLD, 1974) has illustrated this species which, according to him, occurs in the Pamirs and Turkestan and mentions a similar species, *Plebejus lucifera* (Stgr.) from Tibet and Mongolia, with the underside markings more distinct. However, Ta Tsien Lou, the location from which several *P. eversmanni* in the British Museum (NH) have been taken, is at 30° 3′ N, 102°10′ E, a little over 26° of longitud east of the Pamirs. I was unable to locate Yaregong.

On the basis of the above, I hereby report the occurrence of *Plebejus eversmanni* from Malari in Uttar Pradesh, at present in the collection of the Rev. Alan Bean at the University Museum in Oxford, U.K., with the following data:

Malari, N. Uttar Pradesh, 3000 m. Peter Smetacek, 21 August 1987, SN 8532, slide of genitalia mounted with specimen.

I am grateful to the Rev. Alan Bean for his help in identifying this specimen, to Basil Wirth for photographing it and to Dr. Philip Ackery for permission to compare specimens in the British Museum (N.H.) London.

August 8, 1992 PETER SMETACEK

36. CANNIBALISM AMONG IMMATURES OF *PHLEBOTOMUS PAPATAST* (DIPTERA: PSYCHODIDAE)

Cannibalism is one of the biotic interactions among the members of a population to regulate the optimum carrying capacity of the habitat for proper utilization of the available resources (Kerb 1972, Odum 1971). This behavioural trait has also been reported in larvae of certain species of dipterous insects (Shoukry 1980). Extensive studies have been carried out on this aspect in different species of mosquitoes (Corbet and Griffiths 1963). However, the phenomenon has not yet been reported in the immatures of sandflies. Therefore a study was carried out on cannibalism among the immatures of *Phlebotomus papatasi* under different conditions of food availability and density, and the results obtained are presented.

Material and Methods

To find out the extent of cannibalism two sets of experiments with five replicates were conducted. Each replicate of the first set of experiments was started with 100 freshly hatched larvae and maintained with standard larval diet, viz. a 1:1 mixture of white clay and rabbit faecal pellets, and that of the second set without any food right from the beginning of the experiment. Observations were made daily and the number of larvae surviving were recorded until the pupation and emergence. Larvae that were found dead without any injury were categorised as natural mortality. The number of head capsules without exuvium of the body were reckoned as consumed.

To find out the effect of density on cannibalism, freshly hatched first instar larvae of *P. papatasi* were released and reared at different densities, viz. 25, 100, 200 and 400 per container. Containers had a surface area of 7.25 sq. cm. and capacity of 200 ml. The larvae were fed on standard larval diet 'ad libitum' and each set of experiments was replicated three times.

Cannibalistic behaviour was also studied by examining the gut contents. For this purpose a batch of 500 freshly hatched larvae was maintained in a plastic container without providing any food material. About 25 larvae were dissected daily and the gut contents were examined periodically under a compound microscope for the presence of larval parts.

Results and Discussion

Cannibalism was found to occur in both sets of experiments (Table 1). The number of larvae con-

TABLE 1
NUMBER OF *P. papatasi.* LARVAE CONSUMED, DIED AND PUPATED WHEN REARED BATH IN PRESENCE AND ABSENCE OF FOOD

Set	No. consumed Mean ± S.D.	No. died	No. pupated
I, food provided and libitium	3.3 ± 0.4 (3–4)	9.3 ± 1.2 (8–11)	87.3 ± 1.7 (85–89)
II, no food provided	98.0 ± 0.8 (97–99)	2.0 ± 0.8 (1–3)	—

Figures in parentheses denote range.

TABLE 2
NUMBER OF *P. papatasi* LARVAE CONSUMED, DIED AND PUPATED WHEN REARED AT DIFFERENT DENSITIES

Density	No. consumed Mean ± SD	No .died	No. pupated
25	4.0 ± 1.4 (2 -5)	3.3 ± 1.3 (2 -4)	18.0 ± 1.6 (16 -20)
100	37.3 ± 4.9 (31-43)	7.7 ± 1.2 (6-9)	55.0 ± 3.7 (51-60)
200	108.0 ± 6.5 (102-117)	13.7 ± 2.1 (11-16)	78.3 ± 4.9 (72-84)
400	234.3 ± 7.1 (225-242)	19.0 ±5.1 (14-26)	146.7± 4.0 (141-150)

Figures in parentheses denote range.

sumed due to cannibalism in the first set (where food was given 'ad libitum') ranged from 3-4 (mean 3.3 ± 0.4) and the mean number of adults obtained was 87.3± 1.7 (range 85-89). The remaining larvae died due to natural causes.

In the second set, where food was not offered, the number of larvae that died due to cannibalism ranged from 97-99 (mean 98.0 ± 0.8). Cannibalism was first observed on the third day of hatching and was seen at every instar. Very few larvae survived (mean 2.0 ± 0.8) and these also perished, when they were 3rd stage in the absence of food. During cannibalism head capsules and caudal bristles were found to be discarded.

The effect of density on cannibalism is shown in Table 2. Cannibalism was observed at all density levels, but was less at low immature density and more at high density. There was a positive correlation ($r=0.998$; $p=0.0016$) between immature density and cannibalism, which suggests that the increase in density was also responsible for cannibalism.

When a total of 500 live larvae was dissected and the gut contents were examined periodically, remnants of larval parts, i.e. exoskeletal structures (matchstick hairs) were seen. This observation also confirms the occurrence of cannibalistic behaviour in this species. The well developed mandibles in II, III and VI instar larvae with serrated margins facilitate seizing and cutting to pieces of the prey.

From the study it is clear that the immatures of *P. papatasi* are cannibalistic even in the presence of food. Though such behaviour is disadvantageous to the immatures, it may help in maintaining the population under unfavourable conditions, i.e. limitation of food.

ACKNOWLEDGEMENTS

We are grateful to Dr. V. Dhanda, Director, Vector Control Research Centre, Pondicherry for the facilities provided, and to the technical staff of Rearing and Colonization Division for their technical assistance.

R. SRINIVASAN
July 7, 1992 K.N. PANICKER

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37. SOME OBSERVATIONS ON THE BIOLOGY OF *ACALLOPISTUS* SPECIES (COLEOPTERA : CURCULIONIDAE) ON *ABUTILON INDICUM*

(With two plates)

Acallopistus sp. (Subfamily Anthonomi nae) is a pest of the common weed *Abutilon indicum.* The biology of some species of Anthonominae has been studied and Burke (1976) has reviewed the previous work. However, there is no report on the life cycle and other aspects of the *Acallopistus* species, the details of which are included in this communication.

Observations and Discussion

Acallopistus sp. (Plate 1, figs. 1,2) attacks the common weed *Abutilon indicum* (Family Malvaceae). The fruits of *A. indicum* are carcerulus in which false septa appear in the ovary so that at maturity each loculus contains three seeds. The number of chambers around the thalamus varies from 14-19 among different fruits (Plate 1, fig. 3).

The adults appear on the host plant in large numbers during September-October. They feed on leaves, floral parts and the young developing fruits (Plate 1, figs. 4, 5).

Copulation: Copulation commences after the weevils have fed for 4-5 days. Mating occurs mostly during the afternoons, when several pairs in coitus are found within partially open buds or on the petals. Before copulation, when a wandering male encounters a female, it strikes its antennae against her body and immediately mounts her body. The male then moves forward and rubs its snout on her pronotum and occasionally taps it with its antennae. After this, the male slides back, extrudes its aedeagus and establishes genital connection (Plate1, fig. 6). The copulating pair remains stationary throughout the act. A non-receptive female pushes away the male with her hind legs. The time spent in copulation varies from 4.2-14.57 hours.

Oviposition: Egg laying starts 2 to 5 days after the first mating. The female deposits eggs inside the fruit by choosing a place near the base of the fruit (Plate 1, fig. 7). She makes a circular hole in the pericarp with the help of the snout and then turns around to apply the tip of the abdomen against the hole. After a few seconds, the tip of the abdomen is raised and lowered two to three times and an egg is deposited inside the loculus. The female deposits one egg per chamber but all the chambers do not contain eggs. Six to nine eggs have been recorded from one fruit. Similar oviposition behaviour has been recorded in other anthonomids which infest fruits and galls (Burke 1976). The oviposition hole is plugged with a yellowish secretion, secreted by the female. List (1932) has studied a similar habit in *Tachypterellus censors cera.* The females lay 6-78 eggs (average 42.2) per female.

Life cycle: Freshly laid eggs are oval, cream, shining and semi-opaque, each measuring 0.59 x 0.37 mm (Plate 2, fig. 8). The eggs hatch in 6 to 8 days (temp. 26-30°C and R.H. 49-65%). The young larva is whitish cream, with dark brown head (Plate 2, fig. 9). It burrows into the developing seed (Plate 2, fig. 10) and moults twice before attaining maturity (Plate 2, figs. 11, 12). The larva at this stage becomes more active and feeds more rapidly on the adjacent ovarian walls and seeds.

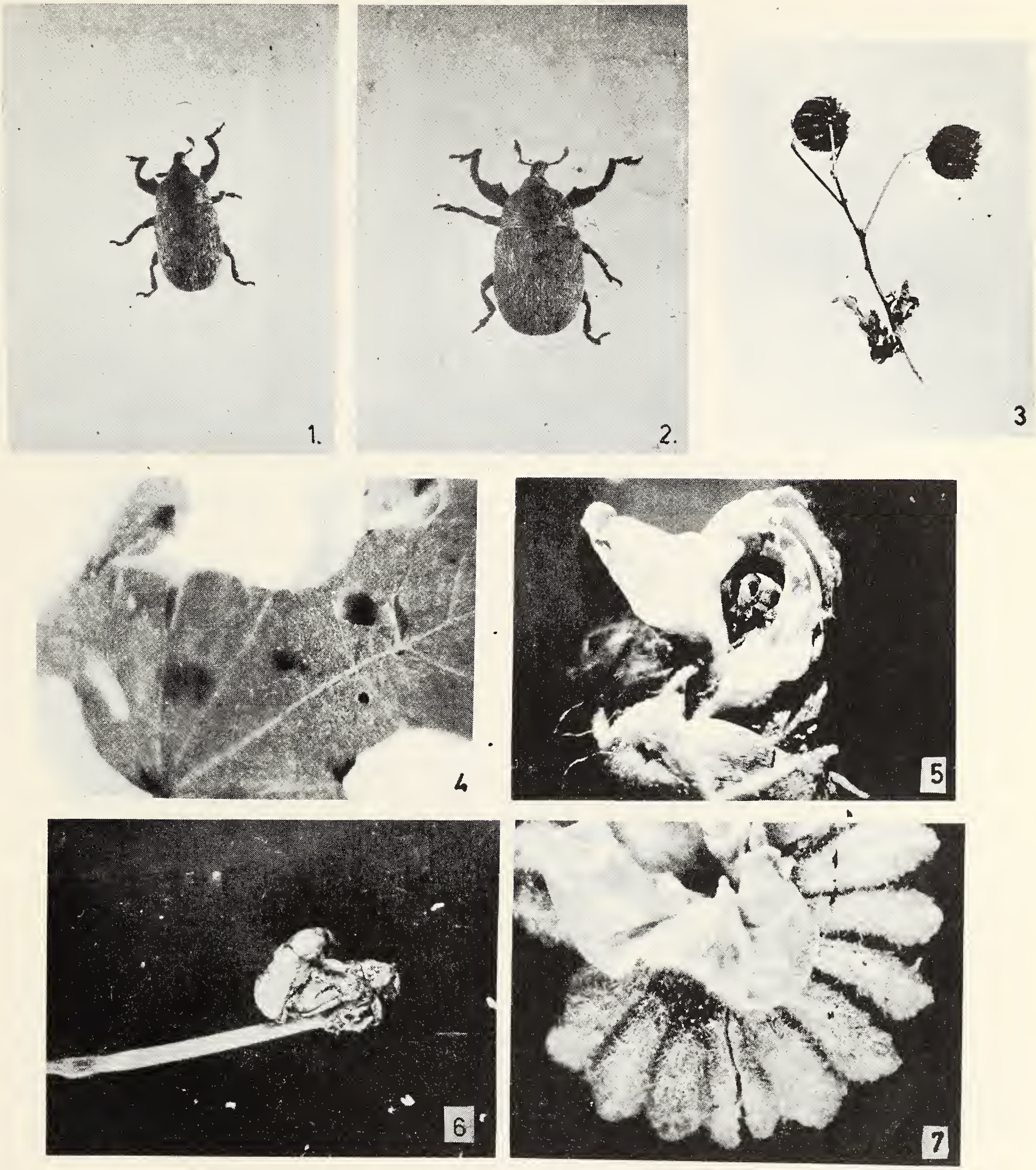
Pupation takes place within the fruit, as in other anthonomid weevils (Burke 1976). The mature larva constructs a chamber at the rear end of the ovary by cementing together the seed fragments and its faecal matter (Plate 2, fig. 13) and transforms into a pupa (Plate 2, fig. 14) in about seven days.

Most pupae transform into adults by the end of October. After eclosion, the adults remain inside the fruit for 5-9 days. During this period, hardening and darkening of the cuticle is completed. The adult ultimately escapes from the fruit by cutting a circular hole (Plate 2, fig. 15).

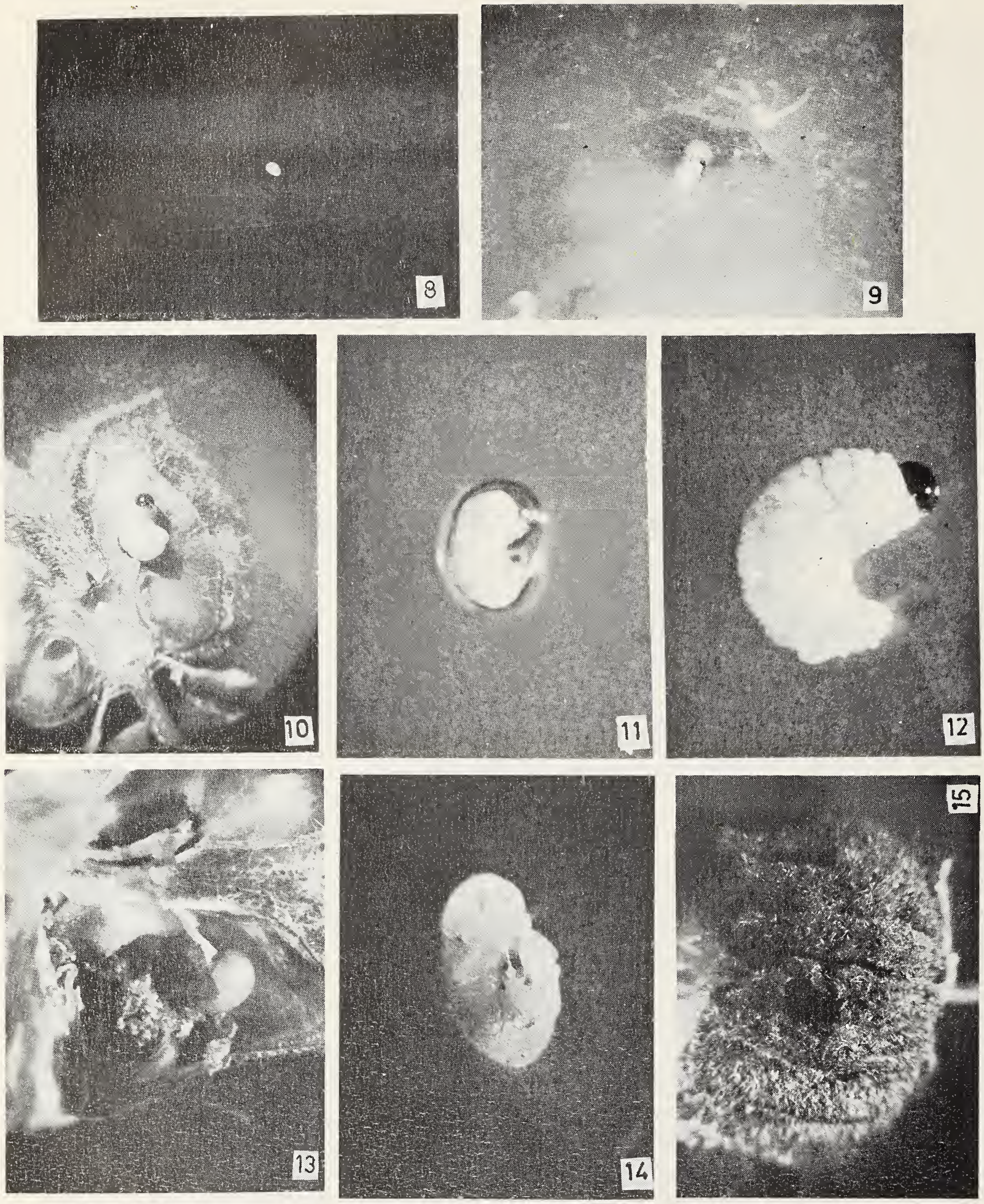
Number of generations: *Acallopistus* sp. is a univoltine species with the adults showing up once in a year. These adults feed for about a month on the late flowers before moving to their hibernation sites, as do most other anthonominae weevils which develop on plants with annual flowering period (Burke 1976).

Nature and extent of damage: As already stated, the adult beetles have been observed to feed on the sepals and pollen of the flowers but the injury may reach to the outer walls of the ovary. It is chiefly the grubs which prove destructive the fruits and usually consume all the seeds of the infested fruit.

The larvae of another weevil, *Apion (Thympion) majorinum* Fab. also inhabiting the thala mus of



Figs. 1-7. *Acallopistus* sp.
1. Male; 2. Female; 3. Adult hiding in the flower; 4. Adult consuming floral parts; 5. Damaged leaf with incised margins; 6. Copulation; 7. Fruit of *Abutilon indicum* with two ovipunctures.



Figs. 8-15. *Acallopistus* sp.

8. Freshly laid egg; 9. First instar larva; 10. Second instar larva; 11. Larva in the ovary of fruit; 12. Third instar larva; 13. Pupation chamber formed of debris of consumed seeds and excretory material; 14. Pupa; 15. Emergence hole of adult on the fruit.

A. indicum (Pajni and Nanda 1989). They mature in the thalamus, thus avoiding competition with the larvae of *Acallopistus.*

ACKNOWLEDGEMENTS

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H.R. PAJNI
January 6, 1992. NEELIMA NANDA

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38. *UVARIA ANDAMANICA* KING (ANNONACEAE) REDISCOVERED FROM ANDAMAN ISLANDS

(With five text-figures)

King (1892, 1893) described *Uvaria andamanica* King from South Andamans based on his collection in 1884 from Port Blair. Parkinson (1923) also included this species in Flora of Andaman Islands. Mitra (1982) cited *U. andamanica* in her revision of tribe Uvarieae for India, only on the basis of type collection deposited in CAL. Vasudeva Rao (1986) listed it merely on the basis of King's report and mentioned that no specimens have been examined from PBL so far.

During the course of exploration of Dhanikhari forest areas in South Andamans one of us collected an *Uvaria* species having unisexual male flowers, which on critical study has been identified as *Uvaria andamanica* King. A thorough scrutiny of the PBL herbarium and recent literature reveals that this species has not been collected after the type collection, though several botanical explorations have been undertaken in all islands of the Andaman group. This taxon is represented by only one or two plants occurring in the inland forest in the vicinity. This report of *Uvaria andamanica* from Dhanikhari, after a lapse of nearly 100 years, with a very small population, indicates that this species has become rare.

Uvaria andamanica King in J. Asiat. Soc. Beng. 61 (2): 21. 1892, et Ann. Roy. Bot. Gard. Cal. 4: 29, t. 25. 1893; C.E. Parkinson, For. Fl. Andaman Islands 79. 1923; Debika Mitra in Fasc. Fl. India 10: 13. 1982; Vasudeva Rao in J. Econ. Tax. Bot. 8: 111. 1986.

Local name: Deosarai.

A woody climber. Stem 2 cm in diameter, rounded, smooth. Leaves 16-22 x 5-10 cm, elliptic-oblong, obovate, rounded at base, acuminate at apex, slightly incurved at margins, coriaceous, nearly glabrous, midrib tomentose; lateral nerves 16-23 pairs, prominent beneath, stellate tomentose. Flowers solitary or two, *c.* 2 cm in diameter, axillary, tomentose, red; bracts 4-5 mm long, solitary, ovate orbicular; pedicels 1-1.2 cm long, tomentose. Sepals three, 7-8 x 4 mm, broadly ovate, reflexed at margins, connate at base, brownish, stellate tomentose without, pubescent within. Petals six, 1 x 0.6 cm, broadly ovate, red, incurved at apex, coriaceous, brown tomentose without, glabrous within. Stamens numerous, 3-4 mm long, narrowly elongate, somewhat ovoid-oblong, flattened at base, apex flat, rounded or nearly bilobed (Figs. 1-5).

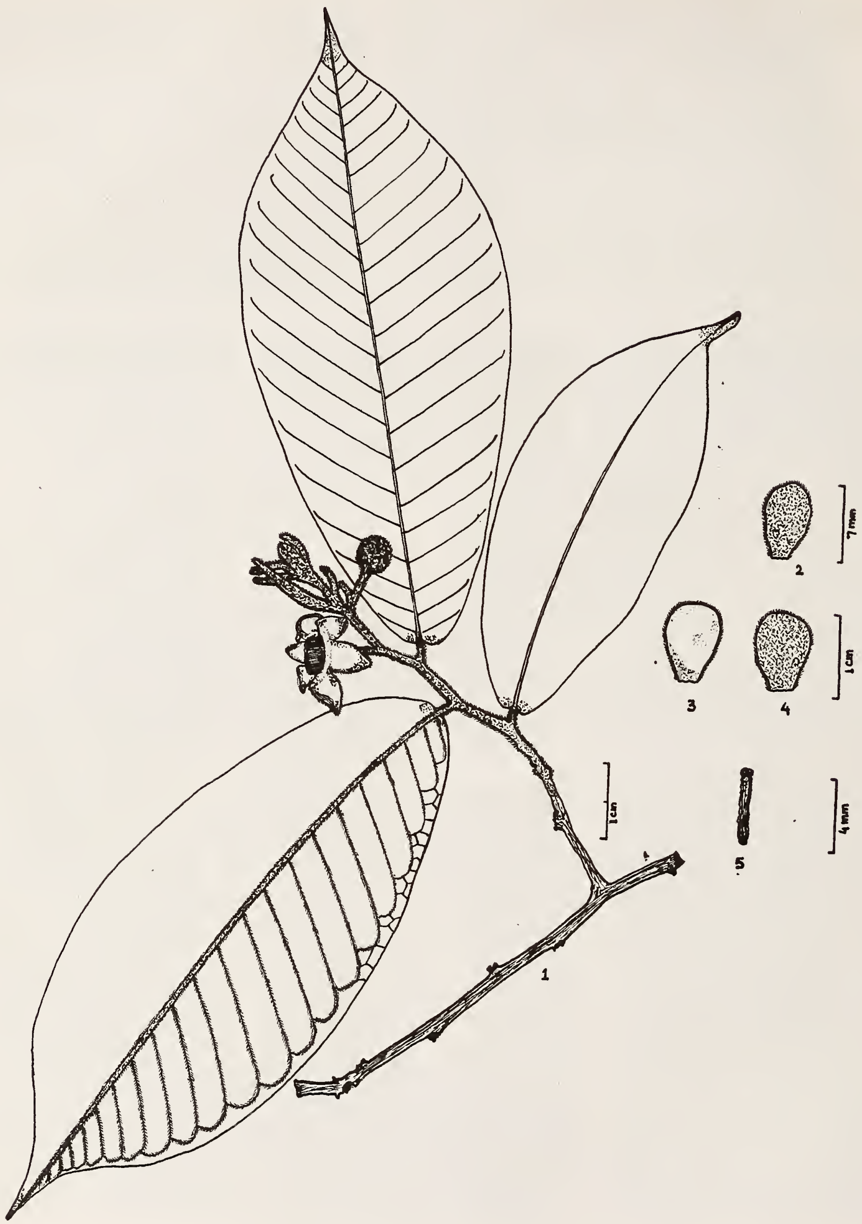
Flowering: March-May.

Distribution: INDIA: Andaman & Nicobar Islands. Rare, endemic.

Ecology: Woody climber growing in inland forest, epiphytic on *Chukrasia tabularis* Andr.-Juss. (Meliaceae) associated with *Gnetum scandens* Roxb., *Randia longiflora* Lamk., *Areca triandra* Roxb., *Garcinia cowa* Roxb. and *Myristica andamanica* Hook.

Uses: Fine twigs of the plant are used as 'Datun' for brushing teeth by the local people.

Exsicc. Andaman & Nicobar Islands: South Andamans, Dhanikhari forest, ± 10 m, 11 March 1990,



Figs. 1-5. *Uvaria andamanica* King
1. Flowering twig; 2. Sepal; 3. Petal (inner surface); 4. Petal (outer surface); 5. Stamen.

Ramesh Kumar 14629 (PBL).

We are thankful to Dr. B.D. Sharma, Director, Botanical Survey of India for providing facilities. Thanks are also due to Dr. P.S.N. Rao, Scientist 'B' in-charge, Andaman & Nicobar Circle, Port Blair for encouragement.

S.K. SRIVASTAVA
RAMESH KUMAR

July 3, 1991

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39. REDISCOVERY OF A RARE FERN *ARCHNIODES ARISTATA* (FROST. F.) TINDALE FROM KUMAUN HIMALAYA

During the course of a botanical exploration in Kumaun Himalaya, a few specimens of a very interesting fern were collected from Hat near Didihat. After critical study, it was identified as *Archniodes aristata* (Frost. f.) Tindale belonging to the family Aspidiaceae. The collection of this species from Kumaun Himalaya is significant for the fern flora of north-western Himalayas, hence information is provided here on the species.

A. aristata (Frost. f.) Tindale, Contr. N.S. Wales Nation Herb. 3: 89, 1961. *Polypodium aristatum* Frost., Prod., 82, 1786. *Lastrea aristata* Moore, Ind. Fil., 85, 1856. *Aspidium aristatum* Clarke, Trans. Linn. Soc. Lond. II Bot. 1: 511, 1880 (excl. vars.).

(For description see Jamir and Rao, FERNS OF NAGALAND: 336. 1988).

Ecology: An extremely rare fern and is nowhere common in the Western Himalaya. It usually grows on moist and humus-rich dark shaded, forest floor, near Hat at 1300 m, and generally sporulates during the month of August.

Specimens examined: Kumaun Himalaya, Pithoragarh district, Hat near Didihat (1300 m), H.C. Pande 24, dated 26 September 1989. Voucher specimens are deposited in Herbarium, Department of Botany, Kumaun University Campus, Almora.

Distribution: INDIA: Western Himalaya; rare in Kumaun West, Eastern Himalaya; S. India; Burma, Sri Lanka, China, W. Australia, Polynesia, Malaya Peninsula and Island, Japan.

The occurrence of this species in north-western Himalayas was reported by Hooker (from Kumaun), MacDonel (from Chamba) vide Hope 1903, and Trotter (from Kashmir) vide Stewart 1945. In 1906 Duthie also reported this species from Kumaun on the authority of Hooker. Recently, Dhir (1980) in FERNS OF NORTH-WESTERN HIMALAYAS and Pande (1990) in CENSUS OF KUMAUN FERNS included this species on the basis of the earlier records. Dixit (1984) also did not mention the distribution of this species in north-western Himalayas. Thus it is clear that none of the subsequent workers could collect this species from any part of north-western Himalayas after Hooker, Trotter and MacDonel. Our collection in 1989 was thus after a long gap. It is in danger of extinction in the Kumaun Himalaya. Therefore, steps should be taken immediately for its conservation. As ferns are very sensitive to habitat destruction, habitat preservation is the only suitable conservation method to protect these plants. Simultaneously efforts should be made to transplant them wherever their peculiar niches are available. This taxon should be incorporated in the National list of Endangered species.

C.S.I.R., New Delhi is acknowledged for financial help.

P. C. PANDE
H.C. PANDE

November 23, 1991

40. *WALSURA PINNATA* HASSK. (MELIACEAE) FROM ANDAMAN ISLANDS — A NEW RECORD FOR INDIAN FLORA

(With a text-figure)

The genus *Walsura* Roxb. has about 40 species mainly distributed in India, South China, Burma, north-west Malaysia, Sumatra, Borneo and Java (Willis 1966). In India, the genus is represented by five species (Santapau and Henry 1973), viz. *W. trifolia* (A. Juss.) Harms, *W. tubulata* Hiern, *W. robusta* Roxb., *W. hypoleuca* Kurz and *W. candollei* King, the last being endemic to the Andaman group of islands.

W. pinnata Hassk., hitherto known to be endemic to Java, is being reported here from Andaman islands, as an addition to the Indian flora. The specimens were collected while exploring the proposed North Andaman Biosphere Reserve areas and also from the Mt. Harriet hill ranges in South Andaman. The following description is provided based on these specimens.

Fig. 1. *Walsura pinnata* Hassk. — twig with inflorescence.

Walsura pinnata Hassk., Retzia, 1: 147. 1963; Backer & Van Den Brink, Fl. Java, 2: 129. 1965.

Trees 10-12 m tall; stem slender, faintly buttressed at the base, bark grey to light brown; branchlets faintly ribbed, pubescent, older parts glabrescent. Leaves up to 30 cm long, imparipinnate; petiole up to 8 cm long; leaflets sub-opposite, 3-5, 12-15 x 3.0-4.5 cm, glaucous beneath, ovate-oblong, entire, retuse or shortly acuminate, lateral nerves 10-13 pairs, conspicuously pink and anastomising below the margin, intercalated veins well developed; petiolules glaucous, 0.8-1.5 cm long (in terminal leaflets up to 5 cm). Flowers in axillary and terminal panicles or corymbs, peduncle and pedicels pink, finely hairy. Sepals 5, 0.7-0.75 x 0.4-0.45 mm, triangular, connate, puberulous. Petals 5, 3.0-3.3 x 1.3-1.5 mm, white, erect-upcurved, ovate-oblong, puberulous. Stamens 10, 1.8-2.0 mm long, hairy around the disc; filaments 1.2-1.5 mm, free or shortly connate, flattened, bidentate at the apex, anthers basifixed, ovoid. Disc annular, puberulous, fleshy. Ovary 2-celled with two ovules in each; style short, stigma broad. Fruit unknown.

Specimens examined: Milannagar, North Andaman Island, 12 December 1990, *P.S.N. Rao* 15718 (PBL); Shole Bay, Mt. Harriet, S. Andaman, 19 May 1990, *Sam P. Mathew* 20539 (PBL).

Distribution: INDIA (Andaman islands) and Java.

As this species occurs nowhere else in India and the distribution being rare with a restricted population of only a few trees, steps should be taken for habitat conservation in view of various developmental activities taking place in the Andamans.

We thank Dr. B.D. Sharma, Director, Botanical Survey of India, Calcutta and K.C. Malick, Scientist - SD, A & N Circle, Botanical Survey of India, Port Blair for encouragement. Thanks are also due to Dr. P.W. Leenhouts and Dr. Max Van Balgooy, Rijksherbarium, Leiden, The Netherlands for confirming the identification of the specimens.

P.S.N. RAO
SAM P. MATHEW

October 16, 1991

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41. *DIGITARIA SIAMENSIS* HENR. (POACEAE) — ADDITION TO THE INDIAN FLORA

(With ten text-figures)

While scrutinising the grasses collected from Santhal Pargana Division of Bihar, we came across an interesting grass collected from Godda district on 5 September 1987, which on critical examination was identified as *Digitaria siamensis* Henr. Earlier this extremely rare grass has been reported from Burma (Hooker 1896 FLORA OF BRITISH INDIA, 7). It was found growing along river banks, associated with *Digitaria stricta* Roth ex Roem. et Schult., *D. setigera* Roth apud Roem. et Schult., *Hetero pogon contortus* (Leduce) P. Beauv. and *Rottboellia cochinchinensis* (L.) Clayton. Apparently the plant shows similarity with *D. stricta* in having clavate-tipped hairs on lower glume and lower lemma. However, it can be readily distinguished from *D. stricta* by the presence of well developed upper glumes, longer spikelets and hairless pedicels.

A collection of the above taxon by Kurz (Acc. no. 518608 CAL) from Rajmahal Hills, is deposited in CAL, Howrah. However, this grass is not mentioned in any literature on grasses of India. Therefore, detailed description, illustration, phenological and ecological notes are given to help in ascertaining its range of distribution in other parts of the country. The voucher specimen is deposited in Bhagalpur University Herbarium.

Digitaria siamensis Henr. Monogr. Gen. Digitaria 692. 1950; Bor, Gr. of Burma, Ceylon, Ind. & Pak. 305. 1960.

Annual, up to 30 cm high. Culms erect, slender, branched at base, glabrous. Leaf-blades 3-15 x 0.3-0.5 cm, linear to linear-lanceolate, minutely scabrid on both surfaces, base narrow, margins scabrid, apex acute; sheaths compressed, up to 12 cm long, keeled, scabrid, margins with tubercle-based hairs; ligules lacerate, up to 5 mm long. Racemes 3-6, up to 12 cm long, alternate on an elongated axis; rhachis not winged, angles scabrid; pedicels unequal, up to 1.5 mm long, minutely scabrid, tip discoid. Spikelets 1.6-2 mm long, elliptic-oblong, acute. Lower glume absent. Upper glume 1.6-2 mm long, 3-nerved, two nerves adjacent to mid nerve, densely clavate-tipped hairs, other glabrous, acute, margins with clavate-tipped hairs. Lower lemma similar to the upper glume, empty, hyaline, 5-nerved, mid-nerve glabrous, two adjacent nerves hairy, margins with clavate-tipped hairs, obtuse, epaleate. Upper lemma 1.5-1.8 mm long, hermaphrodite, coriaceous, glabrous, yellow, apiculate, margins incurved; palea similar to the upper lemma. Stamens three; anthers up to 1.5 mm long.

Flowers: August-December.

Ecology: Along river banks, foothills; rare.

Specimens examined: Shibpur, Godda district, 5 September 1987, *R.R. Jha* 6558; Rajmahal Hills, Sahibganj district, *Kurz s.n.* (CAL acc. no. 518608).

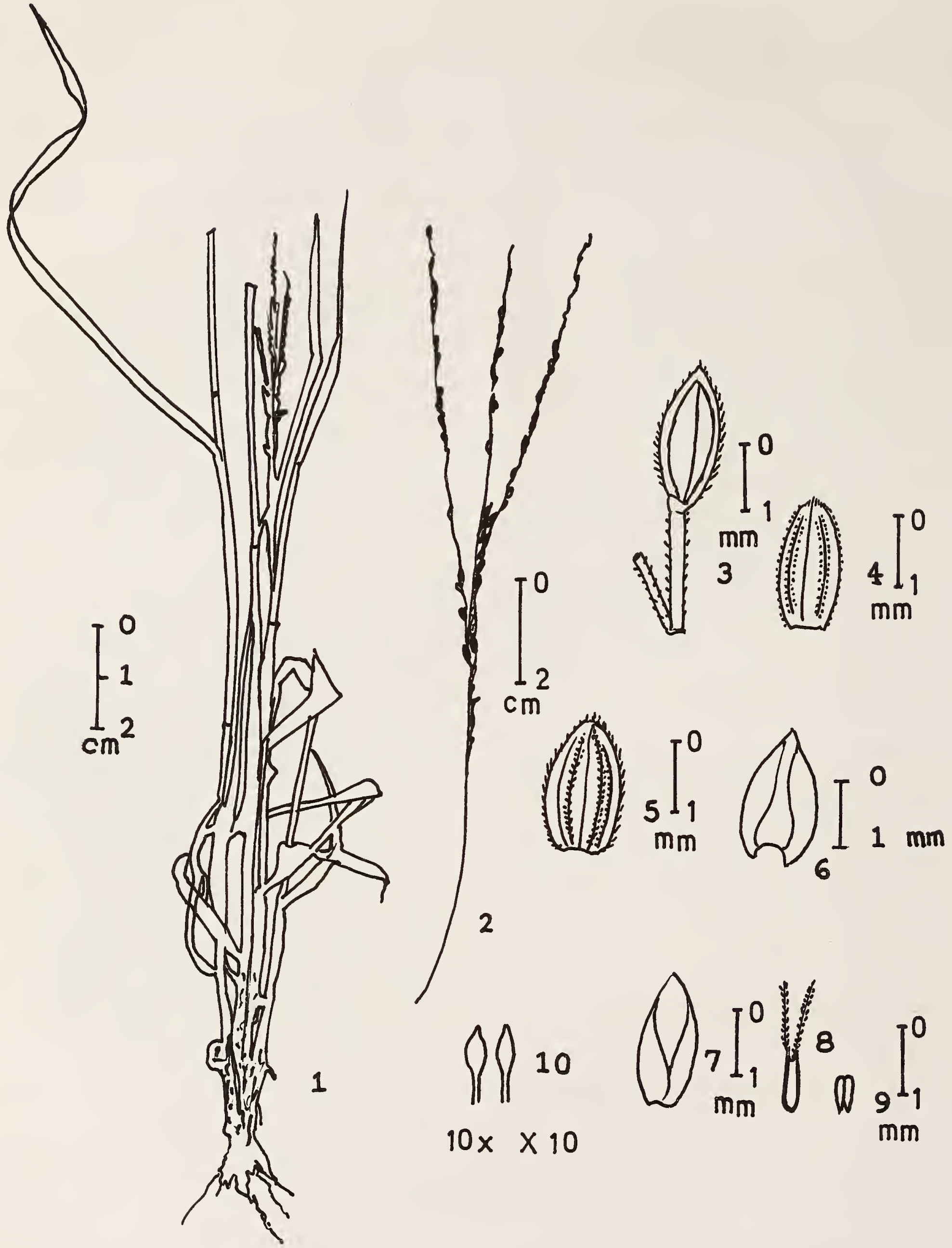
We are greateful to the Joint Director, Central National Herbarium, Indian Botanic Garden, Howrah, for permission to consult the herbarium and CSIR, New Delhi for financial assistance.

R.R. JHA
October 29, 1991 S. K. VARMA

42. LECTOTYPIFICATION OF *BAUHINIA GLAUCA* SSP. *TENUIFLORA* (LEGUMINOSAE)

While attempting to designate a lectotype for *Bauhinia glauca* ssp. *tenuiflora* (C.B. Clarke) Larsen & Larsen, a plant originally described from Manipur by Clarke (*J. Linn. Soc. 25:* 18, t.6. 1889), it was observed that Larsen *et al.* (Fl. Cambodge, Laos & Vietnam 18: 184. 1980) cited only the collection of Watt (no. 6915 K, photo. – CAL!) as type material.

However, Clarke (*J. Linn. Soc. 25:* 2. 1889) in



Figs. 1-10. *Digitaria siamensis* Henr.
1. Habit; 2. Inflorescence; 3. Spikelet; 4. Upper glume; 5. Lower lemma; 6. Upper lemma; 7. Palea; 8. Stigma; 9. Stamen; 10. Hairs.

connection with his work on the plants of Kohima and Manipur, stated that Thiselton Dyer had requested him to take up also the collections of Dr. Watt (which were roughly examined and tabulated) in the Kew herbarium so that everything might be known concerning the plants of Kohima and Manipur. But Clarke soon realised that Dr. Watt did not wish him to name and describe his collections, and so based the work solely on his own collections except for the binomials of the new species (in cases where proposed by Watt in MSS.) which he had come across while comparing his own collections With those of Watt. Hence, the collections (*C.B. Clarke* 42255, 42304 and 42342) of this taxon cited in the protologue should be the most appropriate material for lectotypification rather than that of Watt's, where the name was initially proposed – a decision also in conformity with Article 7.4 of ICBN (Berlin Code 1988).

Thus from the existing syntypes: Nongjaibang, Muneypoor, 1700 ft., 30 Nov. 1985, *C.B. Clarke* 42304 D (CAL!), E (K, photo.– CAL!); 42342 A (K, photo. – CAL!), B (CAL!) – "A loose pod mounted on the same herbarium sheet bearing the flowering specimen *C.B. Clarke* 42304 D (CAL)." and C (K, photo.– CAL!) we select *C.B. Clarke* 42304 E (K) as its lectotype.

We are thankful to the authorities of the Royal Botanic Gardens, Kew for providing the type photographs.

S. BANDYOPADHYAY
B. D. SHARMA

October 21, 1991

ERRATA

Vol. 89(1)

Miscellaneous Note No. 32. Record of the cone shell *Conus cumingii* (Reeve, 1848) from Bombay seas.

p. 143, left column

For In some of these publications the occurrence of *C. cumingii* has been mentioned.

Read In none of these publications has the occurrence of *C. cumingii* been mentioned.

ERRATA

Vol. 89(3)

Wintering Water Birds at point Calimere, Tamil Nadu
On p. 324, Right column,
Line 1,
For Chklidonias hybrida
Read *Chlidonias hybrida*
Line 2,
For comon *Read* common

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